National Aeronautics and
Space Administration

**Lyndon B. Johnson Space Center**
**Houston, Texas 77058**

November 2000

# Space and Life Sciences
# Criticality 3
# System Requirements Document
# for
# Joint Excursion System (JES)

LS-XXXX

# PROJECT DOCUMENT APPROVAL SHEET

| document number | DATE | NO. OF PAGES |
|---|---|---|
| LS- | | |

**TITLE:**

Space and Life Sciences
System Requirements Document
for
Joint Excursion System (JES)

| | |
|---|---|
| APPROVED: | EA5/E. Bauer<br>Hardware Development Project Manager |
| APPROVED: | SF2/D. Grounds<br>HRF Program Manager |
| APPROVED: | |

| DATE | PREPARED BY | CHANGE APPROVALS | CHANGE NUMBER |
|---|---|---|---|
| | | | |

**REPORT NUMBER** LS-XXXXX **DATE**

Space and Life Sciences
System Requirements Document
for
Joint Excursion System (JES)

PREPARED BY: _____ _____
G. Dalrymple Date
HRF Experiment Project Engineer

APPROVED: _____ _____
L. Walters Date
HRF SE&I

APPROVED: _____ _____
Sharad Bhaskaran Date
Manager, HRF System Integration and Development Department

APPROVED: _____ _____
Don Kilbourn Date
Manager, S&PA Department

**Prepared By**

Lockheed Martin Space Operations
Houston, Texas
for
National Aeronautics and Space Administration
Johnson Space Center

**REVISION/CHANGE APPROVALS**

| DATE | REVISION LETTER | CHANGE NUMBER | PREPARED BY | APPROVED BY: | | |
|---|---|---|---|---|---|---|
| | | | | UNIT MANAGER | SR&QA MANAGER | PROJECTS MANAGER |
| | | | | | | |

| document number<br>LS-XXXXX | **DOCUMENT CHANGE/ REVISION LOG** | page 1 OF 1 |
|---|---|---|

| CHANGE/ REVISION | DATE | DESCRIPTION OF CHANGE | PAGES AFFECTED |
|---|---|---|---|
| Basic | | | |

ALTERED PAGES MUST BE TYPED AND DISTRIBUTED FOR INSERTION.

## *Preface*

*This System Requirements Document (SRD) defines the requirements for JES to be placed on the International Space Station (ISS) and used with Human Research Facility (HRF) equipment. This document is under the control of the HRF Configuration Control Board (CCB).*

_____

HRF CCB Chair DATE

CONTENTS

CONTENTS (Cont'd)

CONTENTS (Cont'd)

CONTENTS (Cont'd)

CONTENTS (Cont'd)

CONTENTS (Cont'd)

CONTENTS (Cont'd)

LIST OF TABLES

LIST OF FIGURES

# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AC | Alternating Current |
| ADP | Acceptance Data Package |
| APM | Attached Pressurized Module |
| AVT | Acceptance Vibration Testing |
| C&DH | Command and Data Handling |
| CAM | Centrifuge Accommodation Module |
| CCB | Configuration Control Board |
| CFU | Colony Forming Units |
| CI | Cargo Integration |
| cm | centimeters |
| COTS | Commercial Off-the-Shelf |
| CSCI | Computer Software Configuration Item |
| dB | Decibels |
| DBA | Acoustic Decibel Level |
| DC | Direct Current |
| DGCS | Display and Graphics Commonality Standard |
| DR | Discrepancy Report |
| EEE | Electrical, Electronic, and Electromechanical |
| EMC | Electromagnetic Compatibility |
| EPCE | Electrical Power Consuming Equipment |
| ESD | Electrostatic Discharge |
| EUE | Experiment Unique Equipment |
| FIAR | Failure Investigation Analysis Report |
| FMEA | Failure Modes and Effects Analysis |
| FPD | Flight Projects Division |
| GFCI | Ground Fault Circuit Interrupter |
| GPVP | Generic Payload Verification Plan |
| GSE | Ground Support Equipment |
| HR | Hazard Report |
| HRD | Hardware Requirements Document |
| HRF | Human Research Facility |
| Hz | Hertz |
| ICD | Interface Control Document |
| IDD | Interface Definition Document |
| IMS | Inventory Management System |

| | |
|---|---|
| in | inch |
| ISPR | International Standard Payload Rack |
| ISS | International Space Station |
| ITCS | Internal Thermal Control System |
| IVA | Intravehicular Activity |
| JEM | Japanese Experiment Module |
| JSC | Johnson Space Center |
| KHz | Kilohertz |
| lb | pound |
| lbf | pounds force |
| MDM | Multiplexer-Demultiplexer Module |
| mm | millimeter |
| MPLM | Mini Pressurized Logistics Module |
| MSFC | Marshall Space Flight Center |
| N | Newton (metric force measurement) |
| NASA | National Aeronautics and Space Administration |
| ORU | Orbital Replacement Unit |
| Pa | Pascal |
| para. | paragraph |
| PDA | Pre-Delivery Acceptance |
| PFE | Portable Fire Extinguisher |
| PHTR | Packaging, Handling, and Transportation Records |
| PI | Principal Investigator |
| P/L | Payload |
| PODF | Payload Operations Data File |
| PRD | Program Requirements Document |
| psi | pounds per square inch |
| psia | pounds per square inch absolute |
| PSRP | Payload Safety Review Panel |
| QAVT | Qualification for Acceptance Vibration Testing |
| rms | Root Mean Square |
| RSP | Resupply Stowage Platform |
| SE&I | Systems Engineering and Integration |
| sec | second |

| | |
|---|---|
| SPL | Sound Pressure Level |
| SRD | System Requirements Document |
| SVT | Science Verification Testing |
| TBD | To Be Determined |
| TPS | Task Performance Sheet |
| UIP | Utility Interface Panel |
| UOP | Utility Outlet Panel |
| USL | United States Lab |
| V | Volts |
| VDS | Verification Data Sheet |
| ºC | Degrees Celsius |
| ºF | Degrees Fahrenheit |

## 1.0 SCOPE

This specification defines the Human Research Facility (HRF) program requirements for Joint Excursion System (JES). The JES hardware and software will be used to support the HRF.

The primary governing document for the requirements levied in this document is LS-71000, Program Requirements Document for the Human Research Facility. Other requirements are derived from the experiment unique interface definition documents for the various items of HRF equipment.

The requirements in Sections 3, 4, and 5 of this document consist of a minimum set of constraints for Criticality 3 hardware and software. Criticality 3 items are defined in the table in Section 3.2 of LS-71000.

The HRF Project Office is the controlling authority for this document. The HRF Configuration Control Board (CCB) or a delegated authority must approve any deviations from the requirements of this document. Any change in functionality that requires equipment designated as Criticality 3 to be used in a manner that is not consistent with the requirements specified herein and in LS-71000 will require a reassessment of the item or items for criticality level as well as a reevaluation of applicability to this document.

## 2.0 APPLICABLE DOCUMENTS

The following applicable documents of the exact issue shown herein form a part of this specification to the extent specified herein. If a revision level or date is not cited, the latest version of the document should be used.

All specifications, standards, exhibits, drawings or other documents referenced in this specification are hereby incorporated as cited in the text of this document.

### 2.1 DOCUMENTS

| Document Number | Revision | Document Title |
|---|---|---|
| | | JES IDD |
| FED-STD-595 | *Rev. B 12/89* | Colors Used in Government Procurement |
| LS-71000 | Rev. A 4/00 | Program Requirements Document for the Human Research Facility |
| LS-71011 | *Basic (2/99)* | Acoustic Noise Control and Analysis Plan for Human Research Facility Payloads and Racks |
| LS-71014 | *Draft (9/97)* | Mass Properties Control Plan Human Research Facility Payload and Racks |
| LS-71016 | *Ch. 1 (1/97)* | Electromagnetic Compatibility Control Plan for the Human Research Facility |
| MIL-STD-1686 | *Rev. C 10/95* | Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices) |
| MSFC-STD-250 | *Rev. A 10/77* | Protective Finishes for Space Vehicle Structures and Associated Flight Equipment, General Specification for |
| NASA TM 102179 | *6/91* | Selection of Wires and Circuit Protective Devices for STS Orbiter Vehicle Payload Electrical Circuits |
| NSTS/ISS 13830 | *Rev. C, Ch. 1 7/99* | Implementation Procedure for NSTS Payloads System Safety Requirements for Payloads Using the Space Transportation System |

| Document Number | Revision | Document Title |
|---|---|---|
| NSTS-1700.7 | *Rev. B, Ch. 4 3/97* | Safety Policy and Requirements For Payloads Using the Space Transportation System |
| NSTS-1700.7B ISS Addendum | *12/95* | Safety Policy and Requirements For Payloads Using the International Space Station |
| NSTS/ISS 18798 | *Rev. B, Ch. 3 9/97* | Interpretations of NSTS/ISS Payload Safety Requirements |
| NSTS-21000-IDD-MDK | *Rev. B 02/97 Ch. 2 11/97* | Shuttle Orbiter/Middeck Interface Definition Document Cargo Element Interfaces |
| SN-C-0005 | Rev. C 2/89 | National Space Transportation System Contamination Control Requirements |
| SP-T-0023B | *Rev. B 09/75* | Environmental Acceptance Testing Specification |
| SSP 30233 | *Rev. E 11/95 Rev. F 3/98* | Space Station Requirements for Materials and Processes |
| SSP 30237 | *Rev. D 7/98 Rev. E 10/99* | Space Station Electromagnetic Emission and Susceptibility Requirements |
| SSP 30240 | *Rev. C 6/99* | Space Station Grounding Requirements |
| SSP 30242 | *Rev. D, Ch. 2 6/99 Rev. E 8/99* | Space Station Cable/Wire Design and Control Requirements for Electromagnetic Compatibility |
| SSP 30243 | *Rev. E, Ch. 3 6/99* | Space Station Requirements for Electromagnetic Compatibility |

| Document Number | Revision | Document Title |
|---|---|---|
| SSP 30245 | *Rev. D, Ch. 6 6/99 Rev. E 11/99* | Space Station Electrical Bonding Requirements |
| SSP 30312 | *Rev. F 11/95* | Electrical, Electronic, and Electromechanical (EEE) and Mechanical Parts Management and Implementation Plan International Space Station Program |
| SSP 30512 | *Rev. C 9/94* | Space Station Ionizing Radiation Design Environment |
| SSP 30573 | *Rev. A 10/94* | Space Station Program Fluid Procurement and Use Control Specification |
| SSP 41017 | *Rev. A 10/96 Rev. B 8/98* | Rack to Mini Pressurized Logistics Module Interface Control Document (ICD) Part 1 |
| SSP 41175-2 | *Rev. B 6/97* | Software ICD Part 1 Station Management and Control to International Space Station Book 2, General Software Interface Requirements |
| SSP 50005 | *Rev. B, Ch. 1 9/98* | International Space Station Flight Crew Integration Standard (NASA-STD-3000/T) |
| SSP 50007 | *Rev. A 10/98* | Space Station Inventory Management System Label Specification |
| SSP 50008 | *Rev. B 7/98* | International Space Station Interior Color Scheme |
| SSP 50313 | *Draft* | Display and Graphics Commonality Standard |
| SSP 50467 | *05/99* | ISS Cargo Stowage Technical Manual: Pressurized Volume |
| SSP 52005 | *Rev. B 3/99* | Payload Flight Equipment Requirements and Guidelines for Safety-Critical Structures |
| SSP 52050 | *Rev. A 11/98* | Software Interface Control Document Part 1, International Standard Payload Rack to International Space Station |

| Document Number | Revision | Document Title |
|---|---|---|
| SSP 57000 | Rev. C<br>7/99 | Pressurized Payloads Interface Requirements Document |
| SSP 57001 | *Rev. A*<br>*7/99* | Pressurized Payloads Hardware Interface Control Document Template |

## 2.2 ORDER OF PRECEDENCE

In the event of a conflict between the text of this specification and references cited herein, the text of this specification takes precedence. Nothing in this specification, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

# 3.0 SYSTEM REQUIREMENTS

## 3.1 ITEM DEFINITION

The following items of JES hardware will be designed and certified under this requirements document for use on ISS as a part of the HRF program. HRF, ISS, and/or Shuttle-provided hardware used with this experiment is certified under separate documentation which is maintained by the appropriate program(s).

Table 3.1-1 lists the equipment items covered by this document, including the stowage kits that will be used to transport the items and contain the items on-orbit.

TABLE 3.1-1. JES EQUIPMENT

| Item Name | Part Number | Notes |
|---|---|---|
| HRF JES Display Assembly | SEG46117981-301 | |
| HRF JES 110 Sensor | SEG4611xxxx-301 | |
| HRF JES 180 Sensor | SEG4611xxxx-302 | |
| HRF JES 45 Degree Calibration Assy | SEG4611xxxx-301 | |
| HRF JES 90 Degree Calibration Assy | SEG4611xxxx-302 | |
| HRF JES Stowage Kit | SJG4611xxxx-301 | |
| 9V Battery Kit | SED46107213-302 | |

### 3.1.1 Hardware Description

The Joint Excursion Sensor (JES) provides a means for measuring the full range of motion of instrumented joints. The hardware is based on the Biometrics, Ltd. (formerly Penny & Giles) commercial display unit and sensors. The display unit is small and portable. The system consists of a display unit, calibration template, two angle sensors and cables. The display unit outputs an analog signal that shall be acquired using the Ambulatory Data Acquisition System (ADAS).

#### 3.1.1.1 Hardware Overview

See Hardware Description.

#### 3.1.1.2 Operational Overview

The hardware will be unstowed and setup. One or two sensors will be connected to the JES Display Assembly depending on the experiment. The analog output on

the JES Display Assembly would be connected to the ADAS. Before using the sensors, the operator would place the sensor on a calibration template which positions the sensor at a specific angle. The operator would press the zero button for the sensor channel that was being calibrated. Then, the operator would place the sensor on the desired joint for measurement of its movement. Once the sensor is installed and calibrated, the operator would start the ADAS to record the subjects movements. After use, the hardware would be disassembled and re-stowed.

3.2 CHARACTERISTICS

3.2.1 Performance Characteristics

3.2.1.1 Functional Performance Characteristics

3.2.1.1.1 Number of Data Channels

The JES Display Assembly shall be able to measure to two channels of sensor angle data.

3.2.1.1.2 Display Parameters – Angle Data

The JES Display Assembly shall display the angle data of either channel 1 or channel 2.

3.2.1.1.3 Display Control - Channel Selection

The JES Display Assembly shall be able to switch the display between channel 1 & channel 2.

3.2.1.1.4 Low Battery Indicator

The JES Display Assembly shall have a low battery light.

3.2.1.1.5 Channel Output Zeroing

The JES Display Assembly shall be able to zero the output of each channel by pressing a zero button.

3.2.1.1.6 JES Output Signals

The JES Display Assembly shall provide an analog output for each channel that represents the angle of the sensor.

3.2.1.1.7 Measurement Capability

The JES System shall be able to measure the angle of the ankle, knee & hip joints.

3.2.2 Physical Characteristics

3.2.2.1 Mass Properties

3.2.2.2 Envelope

3.2.2.2.1 Stowed Envelope

3.2.2.2.2 Deployed Envelope

3.2.2.2.2.1 On-Orbit Payload Protrusions

Not Applicable to JES.

3.2.2.2.2.2 Deployed Envelope Dimensions

3.2.3 Reliability, Quality, and Non-Conformance Reporting

A. Reliability and maintainability requirements for the JES shall be as defined in LS-71026, "Human Research Facility (HRF) Reliability Plan." (LS-71000, Section 7.2)

B. Quality Assurance for the HRF Program shall be implemented in accordance with the LS-71030, "Quality Assurance Plan for the Human Research Facility." (LS 71000, Section 7.3.1)

C. Non-Conformance Reporting

1. For flight hardware produced under a contract or subcontract at a site other than JSC, non-conformance reporting requirements shall be specified in the SOW Data Requirements List, and DRDs shall be used to identify the submittal and data requirements. (LS 71000, Section 7.3.2.1)

2. For flight hardware developed at JSC, non-conformance reporting shall be in accordance with JPD 5335.1 and the applicable technical division plan. (LS 71000, Section 7.3.2.2)

3. Non-conformances, which meet the Level 1 Problem Reporting and Corrective Action criteria for payloads as defined in SSP 30223, shall be reported in accordance with SSP 30223. (LS 71000, Section 7.3.2.3)

4. Software non-conformance reporting shall be in accordance with LS-71020-1, "Software Development Plan for the Human Research Facility." (LS 71000, Section 7.3.2.4)

3.2.3.1 Failure Propagation

The design shall preclude propagation of failures from the payload to the environment outside the payload. (NSTS 1700.7B, Section 206)

3.2.3.2 Useful Life

JES hardware shall be designed for a 10 year utilization. (LS-71000, Section 7.2.1)

3.2.3.2.1 Operational Life (Cycles)

Operational life applies to any hardware that deteriorates with the accumulation of operating time and/or cycles and thus requires periodic replacement or refurbishment to maintain acceptable operating characteristics. Operational life includes the usage during flight, ground testing, and pre-launch operations. All components of the JES shall have an operational life limit of 10 years, except those identified as having limited life, see Section 3.2.3.2.3.

3.2.3.2.2 Shelf Life

Shelf life is defined as that period of time during which the components of a system can be stored under controlled conditions and put into service without replacement of parts (beyond servicing and installation of consumables). The JES shall have a shelf life limit of TBD.

3.2.3.2.3 Limited Life

Limited life is defined as the life of a component, subassembly, or assembly that expires prior to the stated useful life in Section 3.2.3.2.1. Limited life items or materials, such as soft goods, shall be identified, and the number of operation cycles shall be determined. Limited life items shall be tracked on a limited life list that is maintained as a part of the hardware acceptance data pack.

3.2.4 Maintainability

A. Payload provided unique tools shall meet the requirements of SSP 50005, paragraph 11.2.3. (LS-71000, Section 6.4.4.2.6.3)

B. Not applicable to JES.

C. Not applicable to JES.

D. Electrical connectors and cable installations shall permit disconnection and reconnection without damage to wiring connectors. (LS-71000, Section 6.4.4.3.2C)

E. Not applicable to JES.

F. Not applicable to JES.

G. Not applicable to JES.

3.2.4.1 Logistics and Maintenance

3.2.4.1.1 Payload In-Flight Maintenance

Not applicable to JES.

3.2.4.1.2 Maintenance

3.2.5 Environmental Conditions

3.2.5.1 On-Orbit Environmental Conditions

3.2.5.1.1 On-Orbit Internal Environments

3.2.5.1.1.1 Pressure

The JES shall be safe when exposed to pressures of 0 to 104.8 kPa (0 to 15.2 psia). (LS-71000, Section 6.3.6.1.1)

3.2.5.1.1.2 Temperature

The JES shall be safe when exposed to temperatures of 10° to 46° C (50 to 115° F). (LS-71000, Section 6.3.6.1.2)

3.2.5.1.1.3 Humidity

Not applicable to JES.

3.2.5.1.2 Use of Cabin Atmosphere

3.2.5.1.2.1 Active Air Exchange

Not applicable to JES.

3.2.5.1.2.2 Oxygen Consumption

Oxygen consumption is defined by ISS for integrated racks only. Maximum leakage rate must be documented in the JES ICD. (LS-71000, Section 6.3.6.2.2)

3.2.5.1.2.3 Chemical Releases

Chemical releases to the cabin air shall be in accordance with paragraphs 209.1a and 209.1b in NSTS 1700.7, ISS Addendum. (LS-71000, Section 6.3.6.2.3)

3.2.5.1.2.4 Cabin Air Heat Leak

Cabin air heat rejection is defined by the ISS program in terms of ISS modules only. No sub-allocation has been made for integrated racks or aisle hardware. JES maximum cabin air heat rejection must be documented in the JES ICD. (LS-71000, Section 6.3.4.2)

3.2.5.1.2.5 Cabin Air Cooling

Not applicable to JES.

3.2.5.1.3 Ionizing Radiation Requirements

3.2.5.1.3.1 Instrument Contained or Generated Ionizing Radiation

Not applicable to JES.

3.2.5.1.3.2 Ionizing Radiation Dose

JES should expect a total dose (including trapped protons and electrons) of 30 Rads (Si) per year of ionizing radiation. A review of the dose estimates in the ISS (SAIC-TN-9550) may show ionizing radiation exposure to be different than 30 Rads (Si) per year, if the intended location of the rack in the ISS is known. (LS-71000, Section 6.3.6.3.2)

3.2.5.1.3.3 Single Event Effect (SEE) Ionizing Radiation

The JES shall be designed not to produce an unsafe condition or one that could cause damage to equipment external to the JES as a result of exposure to SEE ionizing radiation assuming exposure levels specified in SSP 30512, paragraph 3.2.1, with a shielding thickness of 25.4 mm (1000 mils). (LS-71000, Section 6.3.6.3.3)

3.2.5.1.4 Additional Environmental Conditions

The environmental information provided in Table 3.2.5.1.4-1, Environmental Conditions on ISS, and Figure 3.2.5.1.4-1, Operating Limits of the ISS

Atmospheric Total Pressure, Nitrogen and Oxygen Partial Pressures, is for design and analysis purposes. (LS-71000, Section 6.3.6.3.4)

TABLE 3.2.5.1.4-1. ENVIRONMENTAL CONDITIONS ON ISS

| Environmental Condition | Value |
|---|---|
| **Atmospheric Conditions** | |
| Pressure Extremes | 0 to 104.8 kPa (0 to 15.2 psia) |
| Normal operating pressure | See Figure 3.2.5.1.4-1 |
| Oxygen partial pressure | See Figure 3.2.5.1.4-1 |
| Nitrogen partial pressure | See Figure 3.2.5.1.4-1 |
| Dewpoint | 4.4 to 15.6 °C (40 to 60 °F) |
| Percent relative humidity | 25% to 75% |
| Carbon dioxide partial pressure during normal operations with 6 crewmembers plus animals | 24-hr average exposure 5.3 mm Hg<br>Peak exposure 7.6 mm Hg |
| Carbon dioxide partial pressure during crew changeout with 11 crewmembers plus animals | 24-hr average exposure 7.6 mm Hg<br>Peak exposure 10 mm Hg |
| Cabin air temperature in United States Lab (USL), Japanese Experiment Module (JEM), Attached Pressurized Module (APM), and Centrifuge Accommodation Module (CAM) | 17 to 28 °C (63 to 82 °F) |
| Cabin air temperature in Node 1 | 17 to 31 °C (63 to 87 °F) |
| Air velocity | 0.051 to 2.03 m/s (10 to 40 ft/min) |
| Airborne microbes | Less than 1000 Colony Forming Units (CFU)/$m^3$ |
| Atmosphere particulate level | Average less than 1000,000 particles/$ft^3$ for particles less than 0.5 microns in size |
| **Mini Pressurized Logistics Module (MPLM) Air Temperatures** | **Active and Passive Flights** |
| Extremes for all phases of flight | 10 to 46 °C (50 to 114.8 °F) |
| **Thermal Conditions** | |
| Module wall temperature | 13 °C to 43 °C (55 °F to 109 °F) |
| Other integrated payload racks | Front surface less than 37 °C (97 °F) |
| **Microgravity** | TBD |
| General Illumination | 108 Lux (10 fc) measured 30 inches from the floor in the center of the aisle |

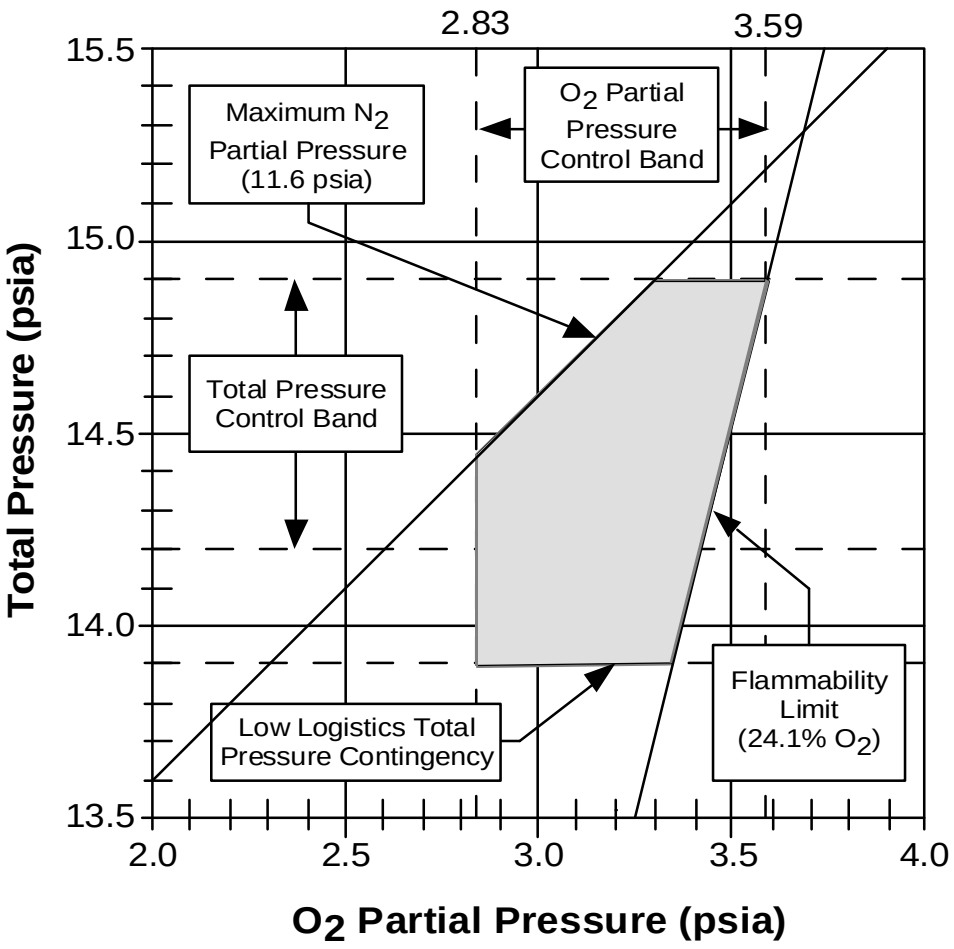



Figure 3.2.5.1.4-1. Operating Limits of the ISS Atmospheric Total Pressure, Nitrogen, and Oxygen Partial Pressures

3.2.5.1.5 Pressure Rate of Change

A. The JES shall maintain positive margins of safety for the on-orbit depress/repress rates in Table 3.2.5.1.5-1. (LS-71000, Section 6.3.1.2B)

TABLE 3.2.5.1.5-1. ISS PRESSURE RATE OF CHANGE

| | |
|---|---|
| Depressurization | 878 Pa/sec (7.64 psi/minute) |
| Repressurization | 230 Pa/sec (2.0 psi/minute) |

B. Deleted.

C. JES shall maintain positive margins of safety for maximum depressurization and repressurization rates for the carrier(s) in which it will be transported. (LS-71000, Section 6.3.1.2A)

(1) JES shall maintain positive margins of safety for maximum depressurization and repressurization rates for the Mini Pressurized Logistics Module (MPLM) documented in Table 3.2.5.1.5-2. (Derived from LS-71000, Section 6.3.1.2A)

TABLE 3.2.5.1.5-2. MPLM PRESSURE RATE OF CHANGE

| | |
|---|---|
| Depressurization | 890 Pa/sec (7.75 psi/minute) |
| Repressurization | 800 Pa/sec (6.96 psi/minute) |

(2) Not applicable to JES.

D. Not applicable to JES.

3.2.5.2 Acoustic Emission Limits

3.2.5.2.1 Continuous Noise Limits

Not applicable to JES.

3.2.5.2.2 Intermittent Noise Limits

A. Not applicable to JES.

B. Not applicable to JES.

3.2.5.3 Instrument Surface Temperature

Not applicable to JES.

3.2.6 Transportability

3.2.6.1 Launch and Landing

The JES shall be transportable to and from orbit. Equipment carried in the Shuttle mid-deck lockers shall be transportable in the Shuttle mid-deck locker to and from orbit, as specified in NSTS-21000-IDD-MDK.

3.2.7 Operational Interface Requirements

3.2.7.1 Mechanical Interface Requirements

3.2.7.1.1 Connector Physical Mate

Not applicable to JES.

3.2.7.2 Electrical Interface Requirements

3.2.7.2.1 Electromagnetic Radiation

3.2.7.2.1.1 Electromagnetic Compatibility (EMC)

Not applicable to JES.

3.2.7.2.1.1.1 Electrical Grounding

Not applicable to JES.

3.2.7.2.1.1.2 Electrical Bonding

Not applicable to JES.

3.2.7.2.1.2 Electromagnetic Interference

A. The JES shall meet all EMI requirements of SSP 30237. (LS-71000, Section 6.3.2.4.4)

NOTE: The alternative use of RS03 stated below applies to radiated susceptibility requirements only. (LS-71000, Section 6.3.2.4.4)

B. Alternately, the payload Electrical Power Consuming Equipment (EPCE) may choose to accept a minimal increase of EMI risk with a somewhat less stringent Electric Field Radiated Susceptibility (RS03) requirement on equipment considered to be non-safety critical to the vehicle and crew. The tailored RS03 requirement, shown in Table 3.2.7.2.1.2-1, will hereafter be denoted RS03PL. (LS-71000, Section 6.3.2.4.4)

TABLE 3.2.7.2.1.2-1. RS03PL

| FREQUENCY | RS03PL LIMIT (V/m) |
|---|---|
| 14 kHz - 400 MHz | 5 |
| 400 MHz - 450 MHz | 30 |
| 450 MHz - 1 GHz | 5 |
| 1 GHz - 5 GHz | 25 |
| 5 GHz - 6 GHz | 60 |
| 6 GHz - 10 GHz | 20 |
| 13.7 GHz - 15.2 GHz | 25 |

Comments: The less stringent RS03PL limit was developed to envelope the electric fields generated by ISS transmitters and ground-based radars tasked to perform space surveillance and tracking. Ground-based radars that are not tasked to track the ISS and search radars that could momentarily sweep over the ISS are not enveloped by the relaxed RS03PL. For most scientific payloads, the minimal increase of EMI risk for the reduced limits is acceptable. The RS03PL limit does not account for module electric field shielding effectiveness that could theoretically reduce the limits even more. Although shielding effectiveness exists, it is highly dependent on the EPCE location within the module with respect to ISS windows.

3.2.7.2.2 Electrostatic Discharge

A. Unpowered JES EPCE shall not be damaged by Electrostatic Discharge (ESD) equal to or less than 4000 V to the case or any pin on external connectors. (LS-71000, Section 6.3.2.5)

B. JES EPCE that may be damaged by ESD between 4000 V and 15,000 V shall have a label affixed to the case in a location clearly visible in the installed position. (LS-71000, Section 6.3.2.5)

C. Labeling of JES EPCE susceptible to ESD up to 15,000 V shall be in accordance with MIL-STD-1686. (LS-71000, Section 6.3.2.5)

NOTE: These voltages are the result of charges that may be accumulated and discharged from ground personnel or crewmembers during equipment installation or removal. (LS-71000, Section 6.3.2.5)

3.2.7.2.3 Corona

The JES shall be designed to preclude damaging or destructive corona in its operating environment. Guidance for meeting the corona requirement is found in MSFC-STD-531, High Voltage Design Criteria. Per MIL-STD-531, corona is a luminous discharge due to the ionization of the gas surrounding a conductor around which exists a voltage gradient exceeding a certain critical value. (LS-71000, Section 6.3.2.8)

3.2.7.2.4 Cable/Wire Design and Control Requirements

Not applicable to JES.

3.2.7.2.4.1 Wire Derating

A. Deleted.

B. Not applicable to JES.

3.2.7.2.4.2 Exclusive Power Feeds

Not applicable to JES.

3.2.7.2.5 Loss of Power

Not applicable to JES.

3.2.7.2.6 Alternating Current Magnetic Fields

The generated Alternating Current (AC) magnetic fields, measured at a distance of 7 centimeters (cm) from the generating equipment, shall not exceed 140 dB above 1 picotesla for frequencies ranging from 30 Hz to 2 KHz, then falling 40 dB per decade to 50 KHz. (LS-71000, Section 6.3.2.6)

3.2.7.2.7 Direct Current Magnetic Fields

The generated Direct Current (DC) magnetic fields shall not exceed 170 dB picotesla at a distance of 7 cm from the generating equipment. This applies to electromagnetic and permanent magnetic devices. (LS-71000, Section 6.3.2.7)

3.2.7.3 Command and Data Handling Interface Requirements

The following requirements are defined for HRF Flight Software.

3.2.7.3.1 Word/Byte Notations, Types and Data Transmissions

3.2.7.3.1.1 Word/Byte Notations

HRF rack independent instruments shall use the word/byte notations as specified in paragraph 3.1.1, Notations in SSP 52050. (LS-71000, Section 6.3.3.1.1)

3.2.7.3.1.2 Data Types

HRF rack independent instruments shall use the data types as specified in paragraph 3.2.1 and subsections, Data Formats in SSP 52050. (LS-71000, Section 6.3.3.1.2)

3.2.7.3.2 HRF Software Requirements

A. The rack independent instrument software shall execute in the environment described in the host system Interface Definition Document (IDD). (Workstation, Laptop, Common Software) (LS-71000, Section 6.3.3.2B)

B. The Rack independent instruments software executable shall generate consistent results given the same initialization data. (LS-71000, Section 6.3.3.2C)

C. Display and Graphics Commonality Standards (DGCS)

(1) Not applicable to JES.

(2) All other payload user interface software shall be in accordance with SSP 50313.

(NOTE: SSP 50313 has not been baselined. The applicable standards can be obtained by downloading the current version of the standard from the web at: http://139.169.159.8/idags/dgcs.html). (LS-71000, Section 6.3.3.2D)

D. Not applicable to JES.

3.2.7.3.3 International Space Station Command and Data Handling Services Through HRF Common Software Interface

Not Applicable to JES.

3.2.7.3.4 Computer Software Configuration Item Adaptation Requirements

A. There are no CSCI adaptation requirements for the [CSCI ID Name]. (LS-71000, Section 6.3.3.2A)

B. The [CSCI ID Name] shall read file pathnames required for proper execution of the software from a configuration file rather than from a file pathname “hard coded” in the software. (LS-71000, Section 6.3.3.2A)

3.2.7.4 Fire Protection Interface Requirements

Fire detection requirements for instruments operated outside of rack volumes have not been defined by ISS. Fire detection methodology for instruments operated outside of rack volumes must be approved by the Payload Safety Review Panel (PSRP). Fire protection requirements in this section apply to all instruments. Fire suppression requirements in this section apply for instruments operated outside of the rack volume that have forced air flow. (LS-71000, Section 6.3.7)

3.2.7.4.1 Fire Prevention

The JES shall meet the fire prevention requirements specified in NSTS 1700.7B, ISS Addendum, paragraph 220.10a. (LS-71000, Section 6.3.7.1)

NOTE: Reference in SSP 57000C and LS 71000A to 220.10a is a typographical error. The reference should be to 220.10.

3.2.7.4.2 Fire Suppression

3.2.7.4.2.1 Portable Fire Extinguisher

A. Not applicable to JES.

B. Not applicable to JES.

3.2.7.4.2.2 Fire Suppression Access Port Accessibility

Not applicable to JES.

3.2.7.4.2.3 Fire Suppressant Distribution

Not applicable to JES.

3.2.7.4.3 Labeling

Not applicable to JES.

3.2.7.5 Other Interface Requirements

Not applicable to JES.

3.3 DESIGN AND CONSTRUCTION

3.3.1 Materials, Processes, and Parts

3.3.1.1 Materials and Processes

A. The JES shall use materials and parts that meet the materials requirements

specified in NSTS 1700.7, ISS Addendum, Section 209. (LS-71000, Section 6.3.8.1)

B. COTS parts used in the JES shall meet the materials requirements specified in NSTS 1700.7, ISS Addendum, Section 209. (LS-71000, Section 6.3.8.2)

C. The JES shall conform to Visibly Clean -Sensitive (VC-S) requirements as specified in SN-C-0005. (LS-71000, Section 6.3.8.3)

D. Not applicable to JES.

E. HRF instruments that are intended to remain on-orbit for more than one year shall use fungus resistant materials according to the requirements specified in SSP 30233, paragraph 4.2.10. (LS-71000, Section 6.3.8.4)

3.3.1.2 Sharp Edges and Corner Protection

The JES design within a pressurized module shall protect crewmembers from sharp edges and corners during all crew operations in accordance with NSTS 1700.7, ISS Addendum, paragraph 222.1. (LS-71000, Section 6.4.9.2)

3.3.1.3 Holes

Not applicable to JES.

3.3.1.4 Latches

Not applicable to JES.

3.3.1.5 Screws and Bolts

Threaded ends of screws and bolts accessible by the crew and extending more than 3.0 mm (0.12 in) shall be capped to protect against sharp threads. (LS-71000, Section 6.4.9.5)

3.3.1.6 Securing Pins

Not applicable to JES.

3.3.1.7 Levers, Cranks, Hooks, and Controls

Not applicable to JES.

3.3.1.8 Burrs

Exposed surfaces shall be free of burrs. (LS-71000, Section 6.4.9.8)

3.3.1.9 Locking Wires

A. Not applicable to JES.

B. Not applicable to JES.

3.3.2 Nameplates and Product Marking

3.3.2.1 Equipment Identification

Integrated racks, all (installed in the rack or separately) sub-rack elements, loose equipment, stowage trays, consumables, ORUs, crew accessible connectors and cables, switches, indicators, and controls shall be labeled. Labels are markings of any form [including Inventory Management System (IMS) bar codes] such as decals and placards, which can be adhered, "silk screened," engraved, or otherwise applied directly onto the hardware. Appendix C of SSP 57000C provides instructions for label and decal design and approval. (LS-71000, Section 6.4.7)

3.3.3 Workmanship

The P/L developer shall use workmanship standards agreed to by NASA (JSC/NT3). The P/L developer may use NASA preferred standards located at Workmanship shall be of aerospace quality and shall conform to high grade aerospace manufacturing practices as directed by LS-71030, "Quality Assurance Plan for the Human Research Facility." (LS 71000, Section 7.3.1)

3.3.4 Interchangeability

3.3.5 Safety Requirements

3.3.5.1 Electrical Safety

3.3.5.1.1 Mating/Demating of Powered Connectors

A. The JES shall comply with the requirements for mating/demating of powered connectors specified in NSTS 18798, MA2-99-170. (LS-71000, Section 6.3.2.10.1)
B. The JES shall comply with the requirements for mating/demating of powered connectors specified in NSTS 18798, MA2-99-170. (LS-71000, Section 6.3.2.10.1)

NOTE: The HRF rack or UOP can provide one verifiable upstream inhibit which removes voltage from the UIP and UOP connectors. The module design will provide the verification of the inhibit status at the time the inhibit is inserted. (Derived from LS-71000, Section 6.3.2.10.1)

3.3.5.1.2 Power Switches/Controls

A. Switches/controls performing on/off power functions for the JES shall open (dead-face) all supply circuit conductors except the power return and the equipment grounding conductor while in the power-off position. (LS-71000, Section 6.3.2.10.3A)

B. Power-off markings and/or indications shall be used only if all parts, with the exception of overcurrent devices and associated EMI filters, are disconnected from the supply circuit. (LS-71000, Section 6.3.2.10.3B)

C. Standby, charging, or other descriptive nomenclature shall be used to indicate that the supply circuit is not completely disconnected for this power condition. (LS-71000, Section 6.3.2.10.3C)

3.3.5.1.3 Ground Fault Circuit Interrupters/Portable Equipment DC Sourcing Voltage

Not applicable to JES.

3.3.5.1.4 Portable Equipment/Power Cords

Not applicable to JES.

3.3.6 Human Engineering

3.3.6.1 Closures or Covers Design Requirements

Closures or covers shall be provided for any area of the payload that is not designed for routine cleaning. (LS-71000, Section 6.4.3.1.1)

3.3.6.2 Interior Color

3.3.6.2.1 Rack Mounted Equipment

Not applicable to JES.

3.3.6.2.2 Stowed/Deployable Equipment

The colors and finishes for stowed and deployable equipment, even if it is normally attached to the rack during use shall be as specified below:

A. COTS equipment that is not repackaged by HRF engineers shall be finished as delivered by the manufacturer. (LS-71000, Section 6.4.3.5.2A)

B. Items that are repackaged by HRF engineers shall be finished using anodic film per MIL-A-8625, Type II, Class 2, Dyed Turquoise. Reference FED-

STD-595, Color Specification 15187. (LS-71000, Section 6.4.3.5.2B)

3.3.6.2.3 Colors for Soft Goods

Not applicable to JES.

3.3.6.3 Full Size Range Accommodation

A. All payload workstations and hardware having crew nominal operations and planned maintenance shall be sized to meet the functional reach limits for the 5th percentile Japanese female and yet shall not constrict or confine the body envelope for the 95th percentile American male as specified in SSP 50005, Section 3. (LS-71000, Section 6.4.2.3)

B. COTS equipment shall be as delivered by the manufacturer and is exempted from this requirement.

3.3.6.4 Operation and Control of Payload Equipment

A. Grip Strength

To remove, replace and operate payload hardware, grip strength required shall be less than 254 N (57 lbf). (LS-71000, Section 6.4.1.1A)

B. Linear Forces

Linear forces required to operate or control payload hardware or equipment shall be less than the strength values for the 5th percentile female, defined as 50% of the strength values shown in Figure 3.3.6.4-1 and 60% of the strength values shown in Figure 3.3.6.4-2. (LS-71000, Section 6.4.1.1B)

C. Torque

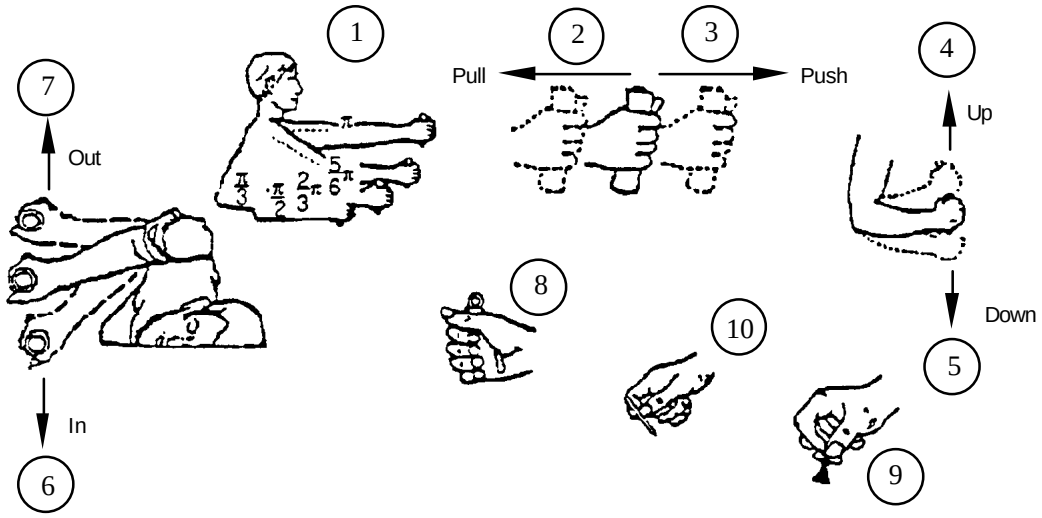
Torque required to operate or control payload hardware or equipment shall be less than the strength values for the 5th percentile female, defined as 60% of the calculated 5th percentile male capability shown in Figure 3.3.6.4-3. (LS-71000, Section 6.4.1.1C)

3.3.6.5 Maintenance Operations

Not applicable to JES.

3.3.6.6 Adequate Clearance

Not applicable to JES.




| Arm Strength (N) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) | (2) | | (3) | | (4) | | (5) | | (6) | | (7) | |
| Degree of elbow flexion (rad) | Pull | | Push | | Up | | Down | | In | | Out | |
| | L** | R** | L | R | L | R | L | R | L | R | L | R |
| ð | 222 | 231 | 187 | 222 | 40 | 62 | 58 | 76 | 58 | 89 | 36 | 62 |
| 5/6 ð | 187 | 249 | 133 | 187 | 67 | 80 | 80 | 89 | 67 | 89 | 36 | 67 |
| 2/3 ð | 151 | 187 | 116 | 160 | 76 | 107 | 93 | 116 | 89 | 98 | 45 | 67 |
| 1/2 ð | 142 | 165 | 98 | 160 | 76 | 89 | 93 | 116 | 71 | 80 | 45 | 71 |
| 1/3 ð | 116 | 107 | 96 | 151 | 67 | 89 | 80 | 89 | 76 | 89 | 53 | 76 |

| Hand and thumb-finger strength (N) | | | | |
|---|---|---|---|---|
| | (8) | | (9) | (10) |
| | Hand Grip | | | |
| | L | R | Thumb-finger grip (Palmer) | Thumb-finger grip (tips) |
| Momentary hold | 250 | 260 | 60 | 60 |
| Sustained hold | 145 | 155 | 35 | 35 |

*Elbow angle shown in radians
**L = Left, R = Right

| Arm strength (lb) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) | (2) | | (3) | | (4) | | (5) | | (6) | | (7) | |
| Degree of elbow flexion (deg) | Pull | | Push | | Up | | Down | | In | | Out | |
| | L | R* | L | R | L | R | L | R | L | R | L | R |
| 180 | 50 | 52 | 42 | 50 | 9 | 14 | 13 | 17 | 13 | 20 | 8 | 14 |
| 150 | 42 | 56 | 30 | 42 | 15 | 18 | 18 | 20 | 15 | 20 | 8 | 15 |
| 120 | 34 | 42 | 26 | 36 | 17 | 24 | 21 | 26 | 20 | 22 | 10 | 15 |
| 90 | 32 | 37 | 22 | 36 | 17 | 20 | 21 | 26 | 16 | 18 | 10 | 16 |
| 60 | 26 | 24 | 22 | 34 | 15 | 20 | 18 | 20 | 17 | 20 | 12 | 17 |

| Hand and thumb-finger strength (lb) | | | | |
|---|---|---|---|---|
| | (8) | | (9) | (10) |
| | Hand Grip | | | |
| | L | R | Thumb-finger grip (Palmer) | Thumb-finger grip (tips) |
| Momentary hold | 56 | 59 | 13 | 13 |
| Sustained hold | 33 | 35 | 8 | 8 |

*Left; R = Right

Figure 3.3.6.4-1. Arm, Hand, and Thumb/Finger Strength (5th Percentile Male Data)

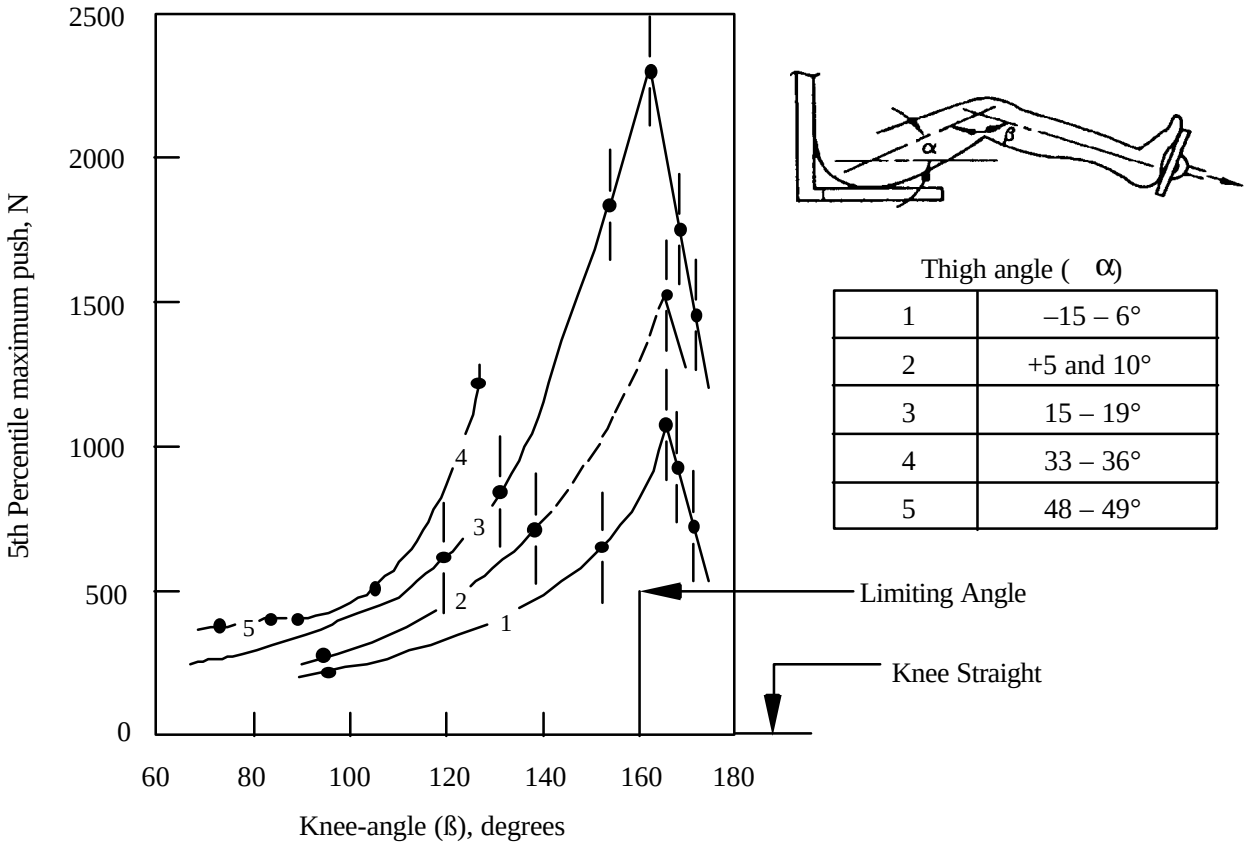



Figure 3.3.6.4-2. Leg Strength at Various Knee and Thigh Angles (5th Percentile Male Data)

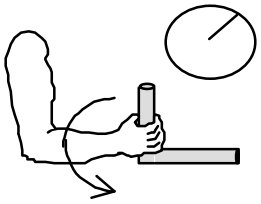
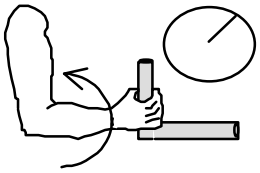
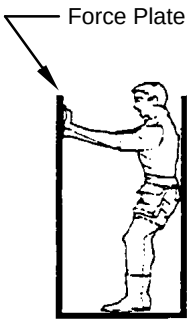
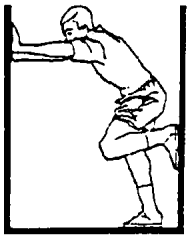
| | Unpressurized suit, bare handed | |
|---|---|---|
| | Mean | SD |
|  Maximum torque: Suppination, Nm (lb.-in.) | 13.73 (121.5) | 3.41 (30.1) |
|  Maximum torque: Pronation, Nm (lb.-in.) | 17.39 (153.9) | 5.08 (45.0) |

Figure 3.3.6.4-3. Torque Strength

| | Force-plate (1) height | Distances (2) | Force, N (lbf) Means | SD |
|---|---|---|---|---|
|  | | | Both hands | |
| | 100 percent of shoulder height | 50 | 583 (131) | 142 (32) |
| | | 60 | 667 (150) | 160 (35) |
| | | 70 | 983 (221) | 271 (61) |
| | | 80 | 1285 (289) | 400 (50) |
| | | 90 | 979 (220) | 382 (68 |
| | | 100 | 645 (145) | 254 (57) |
| | | | Preferred | hand |
| | | 50 | 262 (59) | 67 (15) |
| | | 60 | 298 (67) | 71 (16) |
| | | 70 | 360 (81) | 98 (22) |
| | | 80 | 520 (117) | 142 (32) |
| | | 90 | 494 (111) | 169 (38) |
| | | 100 | 427 (96) | 173 (35) |
| | | Percent of thumb-tip reach* | | |
|  | 100 percent of shoulder height | 50 | 369 (83) | 138 (31) |
| | | 60 | 347 (78) | 125 (28) |
| | | 70 | 520 (117) | 165 (37) |
| | | 80 | 707 (159) | 191 (32) |
| | | 90 | 325 (73) | 133 (35) |
| | | Percent of span** | | |
| | Force-plate (1) height | Distances (2) | Force, N (lbf) Means | SD |
|  | 50 | 100 | 774 (174) | 214 (48) |
| | 50 | 120 | 778 (175) | 165 (37) |
| | 70 | 120 | 818 (184) | 138 (31) |
| | Percent of | shoulder height | 1-g applicable | data |

NOTES:

(1) Height of the center of the force plate - 200 mm (8 in) high by 254 mm (10 in) long - upon which force is applied.
(2) Horizontal distance between the vertical surface of the force plate and the opposing vertical surface (wall or footrest, respectively) against which the subject brace themselves.
() Thumb-tip reach - distance from backrest to tip of subject's thumb as thumb and fingertips are pressed together.
() Span - the maximal distance between a person's fingertips as he extends his arms and hands to each side.
(3) 1-g data.

Figure 3.3.6.5-1. Maximal Static Push Forces

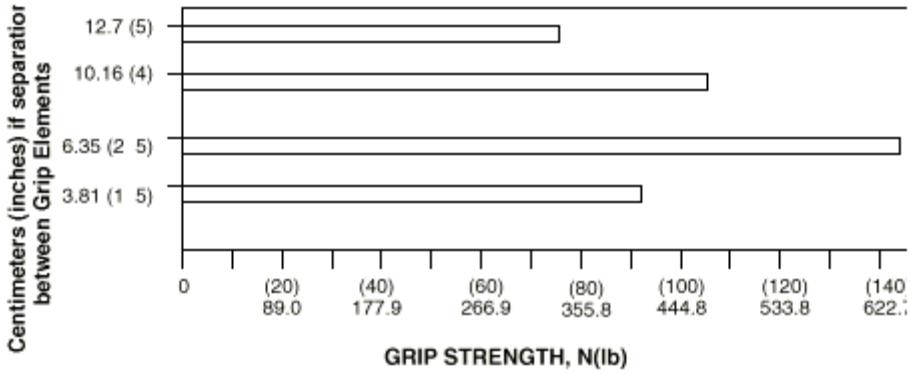



Figure 3.3.6.5-2. Male Grip Strength as a Function of the Separation Between Grip Elements

3.3.6.7 Accessibility

A. Payload hardware shall be geometrically arranged to provide physical and visual access for all payload installation, operations, and maintenance tasks. Payload ORUs should be removable along a straight path until they have cleared the surrounding structure. (LS-71000, Section 6.4.2.2A)

B. Intravehicular Activity (IVA) clearances for finger access shall be provided as given in Figure 3.3.6.7-1. (LS-71000, Section 6.4.2.2B)

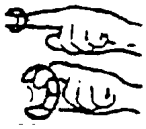
| Minimal finger-access to first joint | | | |
|---|---|---|---|
| Push button access: | Bare hand:<br>Thermal gloved hand: | 32 mm dia (1.26 in.)<br>38 mm dia (1.5 in.) |  |
| Two finger twist access: | Bare hand:<br>Thermal gloved hand: | object plus 50 mm (1.97 in.)<br>object plus 65 mm (2.56 in.) | |

Figure 3.3.6.7-1. Minimum Sizes for Access Openings for Fingers

3.3.6.8 One-Handed Operation

Not applicable to JES.

3.3.6.9 Continuous/Incidental Contact - High Temperature

When payload surfaces whose temperature exceeds 49 °C (120 °F), which are subject to continuous or incidental contact, are exposed to crewmember's bare skin contact, protective equipment shall be provided to the crew and warning labels shall be provided at the surface site. This also applies to surfaces not normally exposed to the cabin in accordance with the NASA IVA Touch Temperature Safety interpretation letter JSC, MA2-95-048. (LS-71000, Section 6.4.3.2.1)

3.3.6.10 Continuous/Incidental Contact - Low Temperature

Not applicable to JES.

3.3.6.11 Equipment Mounting

Equipment items used during nominal operations and planned maintenance shall be designed, labeled, or marked to protect against improper installation. (LS-71000, Section 6.4.4.2.1)

3.3.6.12 Drawers and Hinged Panels

Not applicable to JES.

3.3.6.13 Alignment

Not applicable to JES.

3.3.6.14 Push-Pull Force

Not applicable to JES.

3.3.6.15 Covers

Where physical access is required, one of the following practices shall be followed, with the order of preference given.

A. Provide a sliding or hinged cap or door where debris, moisture, or other foreign materials might otherwise create a problem. (LS-71000, Section 6.4.4.2.6.1A)

B. Provide a quick-opening cover plate if a cap will not meet stress requirements. (LS-71000, Section 6.4.4.2.6.1B)

3.3.6.16 Self-Supporting Covers

All access covers that are not completely removable shall be self-supporting in the open position. (LS-71000, Section 6.4.4.2.6.2)

3.3.6.17 Accessibility

It shall be possible to mate/demate individual connectors without having to remove or mate/demate other connectors during nominal operations. (LS-71000, Section 6.4.4.3.2A)

3.3.6.18 Ease of Disconnect

Electrical connectors shall require no more than two turns to disconnect. (LS-71000, Section 6.4.4.3.3)

3.3.6.19 Self Locking

Payload electrical connectors shall provide a self-locking feature. (LS-71000, Section 6.4.4.3.5)

3.3.6.20 Connector Arrangement

A. Space between connectors and adjacent obstructions shall be a minimum of 25mm (1 inch) for IVA access. (LS-71000, Section 6.4.4.3.6A)

B. Connectors in a single row or staggered rows which are removed sequentially by the crew IVA shall provide 25mm (1 inch) of clearance from other connectors and/or adjacent obstructions for 270 degrees of sweep around each connector beginning at the start of its removal/replacement sequence. (LS-71000, Section 6.4.4.3.6B)

3.3.6.21 Arc Containment

Electrical connector plugs shall be designed to confine/isolate the mate/demate electrical arcs or sparks. (LS-71000, Section 6.4.4.3.7)

3.3.6.22 Connector Protection

Protection shall be provided for all demated connectors against physical damage and contamination. (LS-71000, Section 6.4.4.3.8)

3.3.6.23 Connector Shape

Payload connectors shall use different connector shapes, sizes or keying to prevent mating connectors when lines differ in content. (LS-71000, Section

6.4.4.3.9)

3.3.6.24 Alignment Marks or Guide Pins

Mating parts shall have alignment marks in a visible location during mating or guide pins (or their equivalent). (LS-71000, Section 6.4.4.3.11A)

3.3.6.25 Coding

A. Both halves of mating connectors shall display a code or identifier which is unique to that connection. (LS-71000, Section 6.4.4.3.12A)

B. The labels or codes on connectors shall be located so they are visible when connected or disconnected. (LS-71000, Section 6.4.4.3.12B)

3.3.6.26 Pin Identification

Each pin shall be uniquely identifiable in each electrical plug and each electrical receptacle. At least every 10th pin must be labeled. (LS-71000, Section 6.4.4.3.13)

3.3.6.27 Orientation

Grouped plugs and receptacles shall be oriented so that the aligning pins or equivalent devices are in the same relative position. (LS-71000, Section 6.4.4.3.14)

3.3.6.28 Hose/Cable Restraints

A. Not applicable to JES.

B. Not applicable to JES.

C. Cables should be bundled if multiple cables are running in the same direction and the bundling does not cause EMI. (LS-71000, Section 6.4.4.3.15C)

D. Loose cables (longer than 0.33 meters (1 foot) shall be restrained as follows (LS-71000, Section 6.4.4.3.15D):

| Length (m) | Restraint Pattern (% of length) tolerances +/- 10%) |
|---|---|
| 0.33-1.00 | 50 |
| 1.00-2.00 | 33,67 |
| 2.00-3.00 | 20, 40, 60, 80 |
| >3.00 | at least each 0.5 meters |

3.3.6.29 Non-Threaded Fasteners Status Indication

Not applicable to JES.

3.3.6.30 Mounting Bolt/Fastener Spacing

Not applicable to JES.

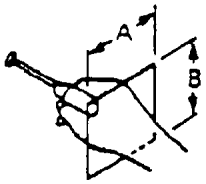
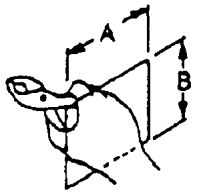
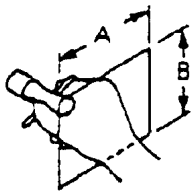
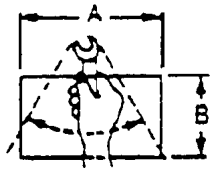
3.3.6.31 Multiple Fasteners

When several fasteners are used on one item they shall be of identical type. (LS-71000, Section 6.4.4.4.3)

NOTE: Phillips or Torque-Set fasteners may be used where fastener installation is permanent relative to planned on-orbit operations or maintenance, or where tool-fastener interface failure can be corrected by replacement of the unit containing the affected fastener with a spare unit.

3.3.6.32 Captive Fasteners

All fasteners planned to be installed and/or removed on-orbit shall be captive when disengaged. (LS-71000, Section 6.4.4.4.4)

| Opening dimensions | | Task |
|---|---|---|
|  | A 117 mm (4.6 in)<br>B 107 mm (4.2 in) | Using common screwdriver with freedom to turn hand through 180° |
|  | A 133 mm (5.2 in)<br>B 115 mm (4.5 in) | Using pliers and similar tools |
|  | A 155 mm (6.1 in)<br>B 135 mm (5.3 in) | Using T-handle wrench with freedom to turn wrench through 180° |
|  | A 203 mm (8.0 in)<br>B 135 mm (5.3 in) | Using open-end wrench with freedom to turn wrench through 62° |

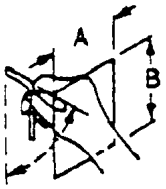
| | | |
|---|---|---|
|  | A 122 mm (4.8 in)<br>B 155 mm (6.1 in) | Using Allen-type wrench with freedom to turn wrench through 62° |

Figure 3.3.6.30-1. Minimal Clearance for Tool-Operated Fasteners

3.3.6.33 Quick Release Fasteners

Not applicable to JES.

3.3.6.34 Threaded Fasteners

Only right-handed threads shall be used. (LS-71000, Section 6.4.4.4.6)

3.3.6.35 Over Center Latches

Not applicable to JES.

3.3.6.36 Winghead Fasteners

Not applicable to JES.

3.3.6.37 Fastener Head Type

A. Hex type external or internal grip or combination head fasteners shall be used where on-orbit crew actuation is planned, e.g., ORU replacement. (LS-71000, Section 6.4.4.4.9A)

B. If a smooth surface is required, flush or oval head internal hex grip fasteners shall be used for fastening. (LS-71000, Section 6.4.4.4.9B)

C. Not applicable to JES.

3.3.6.38 One-Handed Actuation

Fasteners planned to be removed or installed on-orbit shall be designed and placed so they can be mated/demated using either hand. (LS-71000, Section 6.4.4.4.10)

3.3.6.39 Accessibility

IVA fasteners shall be separated to provide hand and tool clearance in accordance with Figure 3.3.6.30-1. (LS-71000, Section 6.4.4.4.11)

3.3.6.40 Access Holes

Not applicable to JES.

3.3.6.41 Controls Spacing Design Requirements

All spacing between controls and adjacent obstructions shall meet the minimum requirements as shown in Figure 3.3.6.41-1, Control Spacing Requirements for Ungloved Operation. (LS-71000, Section 6.4.4.5.1)

3.3.6.42 Protective Methods

Payloads shall provide protection against accidental control actuation using one or more of the protective methods listed in sub-paragraphs A through G below.

Infrequently used controls (i.e., those used for calibration) should be separated from frequently used controls. Leverlock switches or switch covers are strongly recommended for switches related to mission success. Switch guards may not be sufficient to prevent accidental actuation.

A. Locate and orient the controls so that the operator is not likely to strike or move them accidentally in the normal sequence of control movements. (LS-71000, Section 6.4.5.2.1A)

B. Recess, shield, or otherwise surround the controls by physical barriers. The control shall be entirely contained within the envelope described by the recess or barrier. (LS-71000, Section 6.4.5.2.1B)

C. Cover or guard the controls. Safety or lock wire shall not be used. (LS-71000, Section 6.4.5.2.1C)

D. Cover guards when open shall not cover or obscure the protected control or adjacent controls. (LS-71000, Section 6.4.5.2.1D)

E. Provide the controls with interlocks so that extra movement (e.g., lifting switch out of a locked detent position) or the prior operation of a related or locking control is required. (LS-71000, Section 6.4.5.2.1E)

F. Provide the controls with resistance (i.e., viscous or coulomb friction, spring-loading, or inertia) so that definite or sustained effort is required for actuation. (LS-71000, Section 6.4.5.2.1F)

G. Provide the controls with a lock to prevent the control from passing through a position without delay when strict sequential actuation is necessary (i.e., the control moved only to the next position, then delayed). (LS-71000, Section 6.4.5.2.1G)

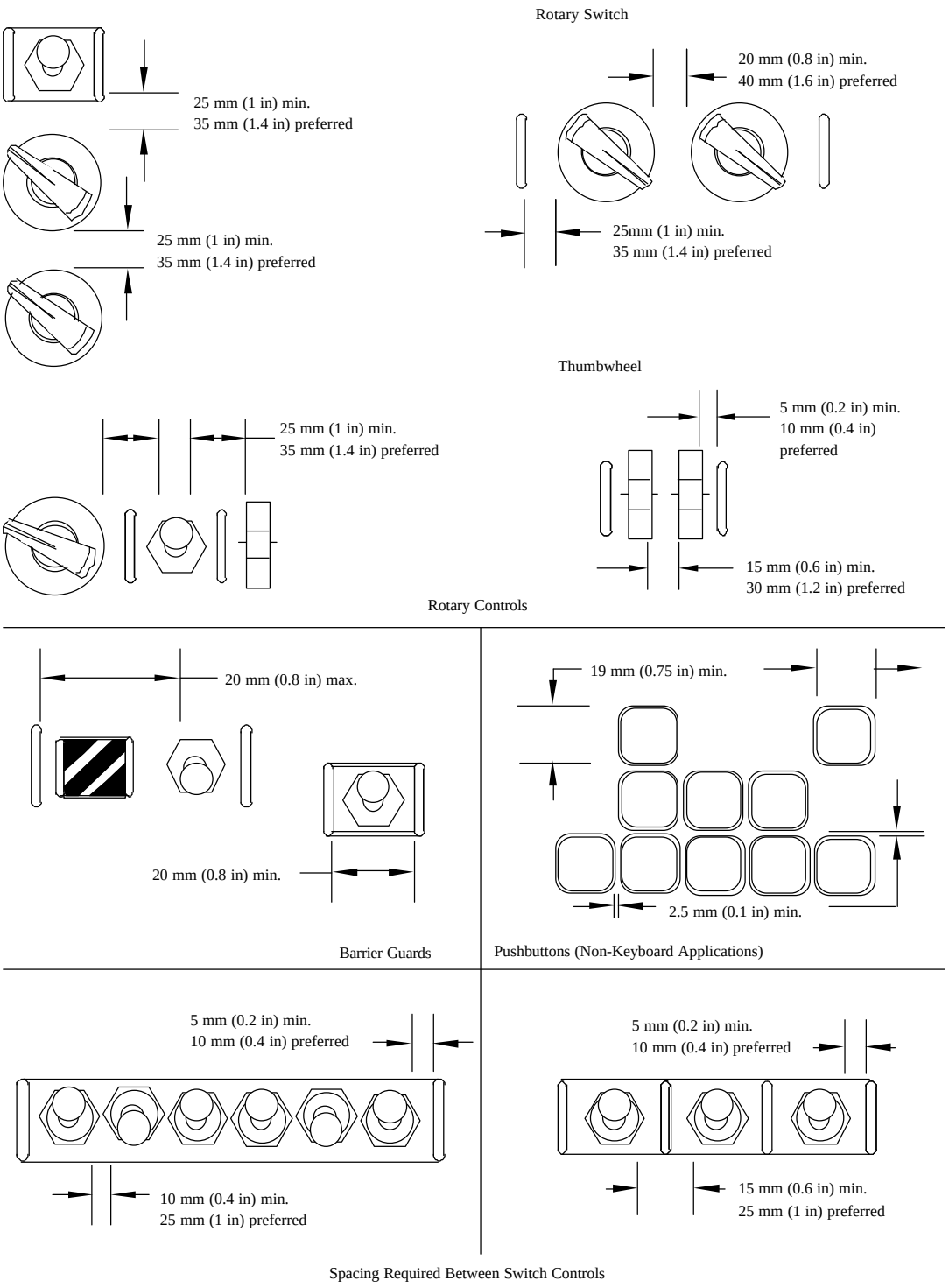



Figure 3.3.6.41-1. Control Spacing Requirements for Ungloved Operation

NOTE: Displays and controls used only for maintenance and adjustments, which could disrupt normal operations if activated, should be protected during normal operations, e.g., by being located separately or guarded/covered.

3.3.6.43 Noninterference

Payload provided protective devices shall not cover or obscure other displays or controls. (LS-71000, Section 6.4.5.2.2)

3.3.6.44 Dead-Man Controls

Not applicable to JES.

3.3.6.45 Barrier Guards

Not applicable to JES.

3.3.6.46 Recessed Switch Protection

Not applicable to JES.

3.3.6.47 Position Indication

When payload switch protective covers are used, control position shall be evident without requiring cover removal. (LS-71000, Section 6.4.5.2.7)

3.3.6.48 Hidden Controls

Not applicable to JES.

3.3.6.49 Hand Controllers

Not applicable to JES.

3.3.6.50 Valve Controls

Not applicable to JES.

3.3.6.51 Toggle Switches

Not applicable to JES.

3.3.6.52 Restraints and Mobility Aids

3.3.6.53 Deleted.

3.3.6.54 Captive Parts

Payloads and payload equipment shall be designed on such a manner to ensure that all unrestrained parts (e.g., locking pins, knobs, handles, lens covers, access plates, or similar devices) that may be temporarily removed on orbit will be

tethered or otherwise held captive.

3.3.6.55 Handles and Restraints

Not applicable to JES.

3.3.6.56 Handle Location/Front Access

Not applicable to JES.

3.3.6.57 Handle Dimensions

Not applicable to JES.

3.3.6.58 Non-Fixed Handles Design Requirements

Not applicable to JES.

3.3.6.59 Electrical Hazards

Not applicable to JES.

3.3.6.60 Mismatched

A. The design of electrical connectors shall make it impossible to inadvertently reverse a connection or mate the wrong connectors if a hazardous condition can be created. (LS-71000, Section 6.4.9.1.1A)

B. Payload and on-orbit support equipment, wire harnesses, and connectors shall be designed such that no blind connections or disconnections must be made during payload installation, operation, removal, or maintenance on orbit unless the design includes scoop proof connectors or other protective features (NSTS 1700.7B, ISS Addendum, paragraph 221). (LS-71000, Section 6.4.9.1.1B)

C. For payload equipment, for which mismating or cross-connection may damage ISS-provided equipment, plugs, and receptacles (connectors), shall be selected and applied such that they cannot be mismatched or cross-connected in the intended system as well as adjacent systems. Although identification markings or labels are required, the use of identification alone is not sufficient to preclude mismating. (LS-71000, Section 6.4.9.1.1C)

D. For all other payload connections, combinations of identification, keying and clocking, and equipment test and checkout procedures shall be employed at the payload's discretion to minimize equipment risk while maximizing on-orbit operability. (LS-71000, Section 6.4.9.1.1D)

3.3.6.61 Device Accessibility

An overload protective device shall not be accessible without opening a door or cover, except that an operating handle or operating button of a circuit breaker, the cap of an extractor-type fuse holder, and similar parts may project outside the enclosure. (LS-71000, Section 6.4.9.1.2.1)

3.3.6.62 Extractor -Type Fuse Holder

The design of the extractor-type fuse holder shall be such that the fuse is extracted when the cap is removed. (LS-71000, Section 6.4.9.1.2.2)

3.3.6.63 Overload Protection Location

Overload protection (fuses and circuit breakers) intended to be manually replaced or physically reset on-orbit shall be located where they can be seen and replaced or reset without removing other components. (LS-71000, Section 6.4.9.1.2.3)

3.3.6.64 Overload Protection Identification

Each overload protector (fuse or circuit breaker) intended to be manually replaced or physically reset on-orbit shall be readily identified or keyed for its proper value. (LS-71000, Section 6.4.9.1.2.4)

3.3.6.65 Automatic Restart Protection

Controls shall be employed that prevent automatic restarting after an overload-initiated shutdown. (LS-71000, Section 6.4.9.1.2.5)

3.3.6.66 Audio Devices (Displays)

Not applicable to JES.

3.3.6.67 Egress

All payload egress requirements shall be in accordance with NSTS 1700.7B, ISS Addendum, paragraph 205. (LS-71000, Section 6.4.9.11)

3.3.7 System Security

3.3.8 Design Requirements

3.3.8.1 Structural Design Requirements

A. JES shall maintain positive margins of safety for launch and landing loading conditions for the carrier(s) in which it will be transported:

(1) Not applicable to JES.

(2) Orbiter Middeck Launch and Landing Loading - based upon acceleration environment as defined in NSTS-21000-IDD-MDK, Table 4.1-1. (LS-71000, Section 6.3.1.3A)

B. JES shall provide positive margins of safety for on-orbit loads of 0.2 Gs acting in any direction. (LS-71000, Section 6.3.1.3B)

3.3.8.1.1 Crew Induced Load Requirements

JES shall provide positive margins of safety when exposed to the crew induced loads defined in Table 3.3.8.1.1-1, Crew-Induced Loads. (LS-71000, Section 6.3.1.3C)

TABLE 3.3.8.1.1-1. Crew-Induced Loads

| Crew System Or Structure | Type Of Load | Load | Direction Of Load |
|---|---|---|---|
| Levers, Handles, Operating Wheels, Controls | Push or Pull concentrated on most extreme edge | 222.6 N (50 lbf), limit | Any direction |
| Small Knobs | Twist (torsion) | 14.9 N-M (11 ft-lbf), limit | Either direction |
| Exposed Utility Lines (Gas, Fluid, and Vacuum) | Push or Pull | 222.6 N (50 lbf), limit | Any direction |
| Cabinets and any normally exposed equipment | Load distributed over a 4 inch by 4 inch area | 556.4 N (125 lbf), limit | Any direction |
| Legend:<br>ft = feet, m = meter, N = Newton, lbf = pounds force | | | |

3.3.8.1.2 Safety Critical Structures Requirements

Not applicable to JES.

3.3.8.2 Electrical Power Consuming Equipment Design

3.3.8.2.1 Batteries

All battery systems shall meet the requirements of NSTS 1700.7, ISS addendum, Section 213.2. (Derived from LS-71000, Section 6.3.2.10)

3.3.8.3 Pressurized Gas Bottle Design

3.3.8.3.1 Pressurized Gas Bottles

Not applicable to JES.

3.3.8.3.2 Manual Valves

Not applicable to JES.

3.4 ACCEPTANCE AND QUALIFICATION REQUIREMENTS

3.4.1 Nominal Operation Under Thermal Environment

JES shall operate nominally under the thermal environment described in 3.2.5.1.1.2.

3.4.2 Workmanship Vibration

JES shall operate nominally following vibration at workmanship levels.

3.4.3 Functional Performance

JES shall operate nominally under all planned modes of operation.

3.4.4 Electrical, Electronic, and Electromechanical Parts Control, Selection, and Burn-In

A. Parts control shall be in accordance with SSP 30312, "Electrical, Electronic, and Electromechanical (EEE) and Mechanical Parts Management and Implementation Plan for Space Station Program."

B. Parts selection for equipment shall be in accordance with:

(1) SSP-30423, "Space Station Approved Electrical, Electronic, and Electromechanical (EEE) Parts List."

(2) SSQ-25002, "Supplemental List of Qualified Electrical, Electronic, Electromechanical (EEE) Parts, Manufacturers, and Laboratories (QEPM&L)."

(3) Semiconductors shall be JANTXV in accordance with MIL-S-19500, "General Specifications for Semiconductor Devices." Diodes shall have a metallurgical bond. Passive parts shall be at least the second highest level of appropriate Military Established Reliability (MIL-ER).

(4) SSP-30512C, "Space Station Ionizing Radiation Design Environment."

Where no alternative is available, nonmilitary parts, components, and subassemblies may be used, but burn-in screening of these items shall be

performed per 3.4.4. C.

C. Burn-in screening shall be completed (100%) on all flight hardware (units).

3.4.5 Flammability

All JES shall meet the flammability test requirements as described in 4.3.5.

3.4.6 Offgassing

All JES hardware located in inhabitable areas shall meet the offgassing test requirements as described in 4.3.6.

3.4.7 Bench Handling

JES shall meet the requirements as described in 4.3.7.

3.4.8 Payload Mass

JES shall meet the payload mass control requirements as described in 4.3.8.

3.4.9 Electromagnetic Compatibility

JES shall meet the EMC control requirements as described in 4.3.9.

3.4.10 Acoustic Noise

JES shall meet the acoustic noise control requirements as described in 4.3.10.

3.4.11 Pre-Delivery Acceptance

JES shall meet the pre-delivery acceptance requirements as described in 4.3.11.

3.5 HUMAN RESEARCH PROGRAM (HRP) PROGRAM REQUIREMENTS

3.5.1 Safety

The JES shall meet the applicable requirements of NSTS 1700.7, NSTS 1700.7 ISS Addendum, NSTS/ISS 18798, NSTS/ISS 13830, and KHB 1700.7.

3.5.2 Experiment Document

3.5.3 Documentation Requirements

Documentation requirements for JES shall be as specified in Appendix A of the PRD for HRF, LS-71000. Required items for submittal to NASA are summarized below for convenience.

3.5.3.1 Acceptance Data Package (ADP)

The contents of the ADP shall be based upon SSP 30695, Acceptance Data Package Requirements Specification but shall also include the following:

| # | Document | Required for Project | | Comments |
|---|---|---|---|---|
| | | Yes | No | |
| 1 | Engineering Drawings | | | |
| 2 | Inventory of Serialized Components | | | |
| 3 | Operating, Maintenance, and Handling Procedures | | | |
| 4 | "As run" Test Procedures, Data, and Reports | | | |
| 5 | Safety Data | | | |
| 6 | Structural Analyses | | | |
| 7 | Radioactive Material Data | | | |
| 8 | Calibration Data | | | |

(1) Engineering Drawings: As-built engineering drawings shall be provided. The drawings shall include the top assembly drawing for each major component and any other drawings necessary to perform receiving inspection and any test or operation to be performed at the destination.

(2) Inventory of Serialized Components: A list of "field replaceable" serialized components will be included in the ADP. The list will contain the component part number, component name, and component serial number.

(3) Operating, Maintenance, and Handling Procedures: Each delivered functional end item shall have a separate manual covering its maintenance, repair, and operation. The manual shall include, but not be limited to, the following (as applicable):

a. Operational instructions suitable to support operator training and containing a system description and general instructions for operating the equipment.

b. Any special handling, packing, transportation or storage procedures (i.e., must be stored/transported in a specific orientation, specific environmental conditions, etc.)

c. A list of special tools, support and facilities equipment, and all other materials necessary to perform maintenance.

d. A schedule chart listing the time at which all maintenance is to be performed. This shall also include inspection for required repair,

maintenance, or replacement of parts.

e. Conditions of environment in which maintenance is to be performed.

f. Detailed maintenance procedures that describe removal, disassembly, type of maintenance or repair, cleaning, reassemble, and reinstallation of all parts or subassemblies. Also included shall be points of inspection and notes of caution.

g. Illustrated part breakdowns showing the details of the part being worked upon.

h. Schematic and interconnecting wiring diagrams in sufficient detail to enable troubleshooting to be performed down to the replaceable subassembly or printed circuit board level.

i. Fault analysis will be provided to facilitate maintenance. The repair procedures shall be adequate for testing, checkout, disassembly, cleaning, inspection, repair, reassembly, adjustment, calibration, and servicing of the equipment as applicable.

(4) "As Run" Test Procedures and Reports: The original "as run" test procedures used for any of the testing required in this Hardware Requirements Document (HRD), along with any associated data and test reports shall be included in the ADP. These procedures shall include quality buy-off if applicable as documented in the Quality Plan.

(5) Safety Data: Copies of hazard reports and other safety data prepared or collected as a result of ground and/or flight safety requirements.

(6) Structural Analyses: Copies of any structural analyses performed as specified in this HRD or required in the contract with NASA.

(7) Radioactive Material Data: If the shipment contains any radioactive material, this section shall include copies of all required data on radioactive material.

(8) Calibration Data: This section shall include any calibration or scaling data required to interpret the output signals from or measurements made using the equipment being shipped.

3.5.3.1.1 ADP Statement in SOW

The SOW for procured flight items shall contain a DRD specifying the above ADP contents.

## 4.0 VERIFICATION PROVISIONS

This section contains the required verification methods for ISS interface certification, science functional acceptance, and program qualification and acceptance. Section 4.1 addresses definitions for terms used herein.

Appendix B contains the applicability matrix for ISS Pressurized Payload Interface Requirements Document requirements. The Verification Data Sheet addressing the appropriate method for ISS interface verification is also contained in Appendix B. If an alternate verification method is desired, the new verification method must be negotiated in the Unique Payload Verification Plan. Section 4.2 contains the verification methods for science functional acceptance. Appendix C contains the applicability matrix for science functional requirements.

Section 4.3 contains the verification methods for program qualification and acceptance requirements. Appendix D contains the applicability matrices for acceptance and qualification requirements.

The responsibility for the performance of all verification activities is as specified in Appendices B, C, and D. All testing described in Appendices B, C, and D shall be documented via TPS (JSC Form 1225) per JSC Work Instruction NT1-CWI-001. Except as otherwise specified in the contract, the provider may use their own or any other facility suitable for the performance of the verification requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the verifications set forth in this specification.

### 4.1 GENERAL

Equipment verification methods are defined as follows:

A. Inspection is a method that determines conformance to requirements by the review of drawings, data or by visual examination of the item using standard quality control methods, without the use of special laboratory procedures.

B. Analysis is a process used in lieu of, or in addition to, other methods to ensure compliance to specification requirements. The selected techniques may include, but not be limited to, engineering analysis, statistics and qualitative analysis, computer and hardware simulations, and analog modeling. Analysis may also include assessing the results of lower level qualification activity. Analysis may be used when it can be determined that (1) rigorous and accurate analysis is possible, (2) test is not cost effective, and (3) verification by inspection is not adequate.

   Verification by similarity is the process of analyzing the specification criteria for hardware configuration and application for an article to determine if it is similar or identical in design, manufacturing process, and quality control to an

existing article that has previously been qualified to equivalent or more stringent specification criteria. Special effort will be made to avoid duplication of previous tests from this or similar programs. If the previous application is considered to be similar, but not equal to or greater in severity, additional qualification tests shall concentrate on the areas of new or increased requirements.

C. Demonstration consists of a qualitative determination of the properties of a test article. This qualitative determination is made through observation, with or without special test equipment or instrumentation, which verifies characteristics such as human engineering features, services, access features, and transportability. Demonstration requirements are normally implemented within a test plan, operations plan, or test procedure.

D. Test is a method in which technical means, such as the use of special equipment, instrumentation, simulation techniques, and the application of established principles and procedures, are used for the evaluation of components, subsystems, and systems to determine compliance with requirements. Test shall be selected as the primary method when analytical techniques do not produce adequate results; failure modes exist which could compromise personnel safety, adversely affect flight systems or payload operation, or result in a loss of mission objectives; or for any components directly associated with Space Station and orbiter interfaces. The analysis of data derived from tests is an integral part of the test program, and should not be confused with analysis as defined above.

## 4.2 FUNCTIONAL PERFORMANCE ACCEPTANCE TESTING

The requirements herein describe specific test requirements for functional performance acceptance.

## 4.3 ACCEPTANCE AND QUALIFICATION VERIFICATION METHODS

The requirements herein describe specific test requirements for JES acceptance and qualification. Qualification testing shall only be performed if qualification articles exist for the hardware. If no qualification articles exist for the hardware, analysis shall be used to qualify the hardware.

### 4.3.1 Thermal Cycle Tests

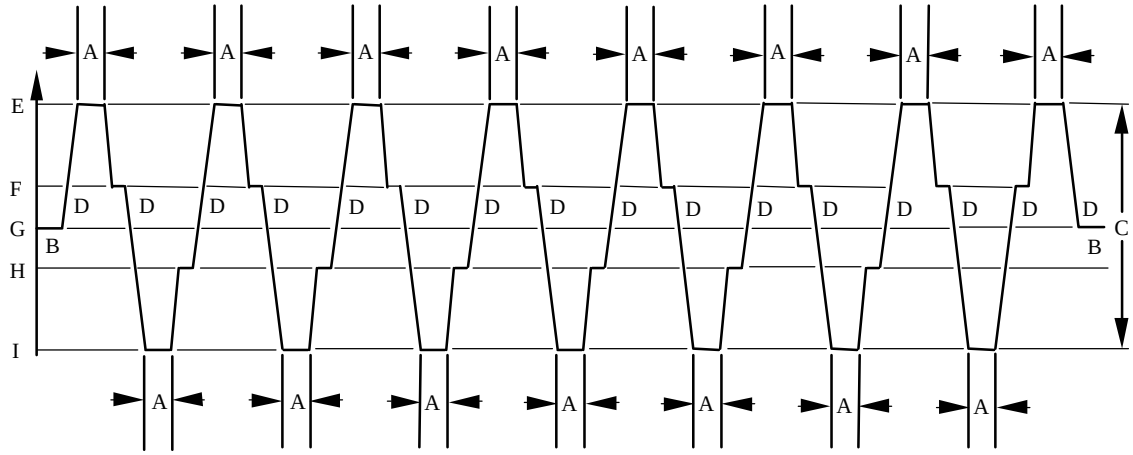
HRF payloads undergoing thermal cycle testing shall be functionally tested at each stable temperature and during transitions. The pass-fail criteria for the functional test and the definition of the functional test will be equipment unique and shall be defined in the test plan and test procedure. Functional tests shall be conducted on end items prior to, during, and after environmental exposure. (LS-71000, Section 5.4.1.1.6)

4.3.1.1 Qualification Thermal Cycling

The Qualification Thermal Cycle Test shall be over a range of 110°F (61.1°C) centered about the normal operating temperature as defined in the individual test plans. The Qualification thermal test shall consist of 7½ cycles. One cycle is defined as starting from normal operating temperature, increasing to the maximum high temperature, decreasing to the minimum low temperature and then returning to the normal operating temperature as depicted in Figure 4.3.1.1-1. The complete test is seven and one-half (7½) cycles with one-hour soaks at each extreme. The hardware will be functionally tested during transitions and at the highest and lowest temperature extremes, consistent with the defined operating temperature range. The hardware shall not be functionally tested at temperatures in excess of the defined operating temperature range. (Hardware shall be unpowered when outside the manufacturer's operating limits.) The specific profile shall be defined in the individual test plans. (LS-71000, Section 5.4.1.1.6.1)

4.3.1.2 Acceptance Thermal Cycling

The acceptance thermal cycle shall be conducted over a temperature range of 100°F (55.6°C) centered about the hardware normal operating temperature as defined in the test plan. The hardware shall be functionally tested before and after the temperature test, at each transition, and at each stable temperature. The hardware shall not be functionally tested at temperatures in excess of the defined operating temperature range. (Hardware shall be unpowered when outside the manufacturer's operating limits.) One cycle is defined as starting from normal operating temperature, increasing to the maximum high temperature, decreasing to the minimum low temperature and then returning to the normal operating

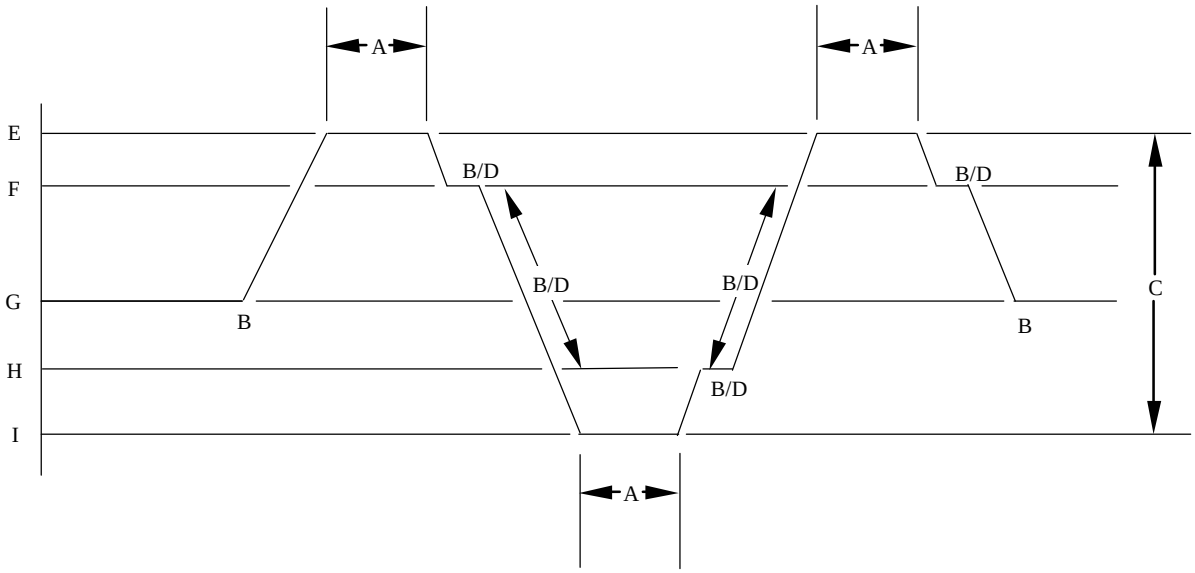



NOTES:

1. A = Time to stabilize equipment temperature plus 1-hour minimum.
2. B = Functional tests to be performed as shown.
3. C = Control temperature range between high and low acceptance test conditions shall be a minimum of 61.11°C (110°F). Contractor is to specify tolerances on stable temperature periods.
4. D = Simplified Functional Test. Rate of temperature change during temperature transition shall not be less than 0.55°C (1°F)/min. nor greater than 2.22°C (4°F) (4°F)/min.
5. E = Median operational temperature plus 30.56°C (55°F).
6. F = Maximum operational temperature.
7. G = Median operational temperature.
8. H = Minimum operational temperature.
9. I = Median operational temperature minus 30.56°C (55°F).

Figure 4.3.1.1-1. Qualification Thermal Cycling

temperature as depicted in Figure 4.3.1.2-1. The complete test consists of one and one-half (1½) thermal cycles with one-hour soaks at each extreme. Minimum temperature sweep shall be 100°F around the normal operating temperature, and the hardware shall dwell at the temperature extremes for a minimum of 1 hour**.** (LS-71000, Section 5.4.1.1.6.2)




NOTES:
1. A = Time to stabilize equipment temperature plus 1-hour minimum.
2. B = Functional tests to be performed as shown.
3. C = Control temperature range between high and low acceptance test conditions shall be a minimum of 55.56°C (100°F). Contractor is to specify tolerances on stable temperature periods.
4. D = Simplified Functional Test. Rate of temperature change during temperature transition shall not be less than 0.55°C (1°F)/min. nor greater than 2.22°C (4°F) (4°F)/min.
5. E = Median operational temperature plus 27.78°C (50°F).
6. F = Maximum operational temperature.
7. G = Median operational temperature.
8. H = Minimum operational temperature.
9. I = Median operational temperature minus 27.78°C (50°F).

Figure 4.3.1.2-1. Acceptance Thermal Cycling

## 4.3.2 Vibration Tests

Qualification for Acceptance Random Vibration Test levels are as described in Section 4.3.2.1. Acceptance Random Vibration Test levels are as described in Section 4.3.2.2.

4.3.2.1 Qualification for Acceptance Random Vibration Test

Qualification for Acceptance Vibration Testing (QAVT) determines the number of Acceptance Vibration Tests that may be run on flight units. QAVT shall be run on dedicated qualification test hardware only. The QAVT for HRF equipment shall be performed at a 7.93 g rms composite level over the frequency range and spectral density defined in Table 4.3.2.1-1. QAVT shall be conducted at 1.69 times the Acceptance Random Vibration Test levels. QAVT duration shall be the Acceptance Vibration Testing (AVT) duration multiplied by the number of AVTs for which the hardware is to be qualified. (LS-71000, Section 5.4.1.1.3.2)

TABLE 4.3.2.1-1. QUALIFICATION ACCEPTANCE RANDOM VIBRATION TEST LEVELS

| **Frequency Range (Hz)** | **Minimum Power Spectral Density ($g^2$/Hz)** |
|---|---|
| 20 | 0.017 |
| 20 - 80 | 3 dB/Octave Slope |
| 80 - 350 | 0.067 |
| 350 - 2000 | -3 dB/Octave Slope |
| 2000 | 0.0118 |
| Composite | 7.93 g rms |

4.3.2.2 Acceptance Random Vibration Test

AVT is used to screen defects in workmanship that cannot be detected by inspection. AVT for JES shall be performed at a 6.1 g rms composite level over the frequency range and minimum AVT levels defined in Table 4.3.2.2-1. Vibration duration shall be a minimum of 60 seconds in each of three axes. Functional/continuity tests shall be conducted on components before, during, and after the AVT. (LS-71000 Section 5.4.1.1.3.3)

TABLE 4.3.2.2-1. ACCEPTANCE RANDOM VIBRATION WORKMANSHIP TEST LEVELS

| Frequency Range (Hz) | Minimum Power Spectral Density ($g^2$/Hz) |
|---|---|
| 20 | 0.01 |
| 20 - 80 | +3 dB/Octave - Slope |
| 80 - 350 | 0.04 |
| 350 - 2000 | -3 dB/Octave - Slope |
| 2000 | 0.007 |
| Composite | 6.1 g rms |

4.3.3 Functional Testing

Abbreviated and full functional test procedures shall be as specified in a TPS or a released procedure.

Functional tests are performed to validate the operation of the JES flight hardware. Functionals make up the core of certain tests and can be performed before and after environmental testing. The functional test done prior to testing establishes the functional state (or baseline) of the hardware while the functional done after testing evaluates its ability to withstand the test levels.

An abbreviated functional will be used to test the functional state of the hardware during some environmental testing (i.e., thermal, vibration, bench handling, etc.). The intended use of an abbreviated functional test is to verify nominal hardware function between test stages.

4.3.4 Electrical, Electronic, and Electromechanical Parts Control, Selection, and Burn-In

A Compliance with 3.4.4.A is considered successful when it can be shown via analysis that the parts control process is compliant with 3.4.4.A.

B. Compliance with 3.4.4.B is considered successful when an analysis is provided that includes a risk assessment, electrical stress analysis, and data delivery on information such as designed/as-built EEE parts, list, construction history, Government and Industry Data Exchange Program (GIDEP) Alerts, part obsolescence, radiation susceptibility, and/or prior history.

C. The burn-in test may be accomplished at the component or assembly level, and is specified as:

- 72 hrs continuously at room ambient temperature while functioning
- 96 hrs continuously at a specified controlled temperature while functioning.

Full functional tests shall be performed on the experiment hardware before and after the burn-in test. Controlled temperature is defined as 15 °C below the maximum rating of the device with the lowest temperature rating in the article under test. (LS-71000, Section 5.4.1.1.10)

All flight assemblies utilizing non-military parts (as specified in Section 3.3.1.2) shall undergo burn-in testing. The test description can be found in Section 3.3.1.2.1. (LS-71000, Section 5.4.1.1.10)

4.3.5 Flammability

Payload materials shall be non-flammable or self-extinguishing per the test criteria of NASA-STD-6001, Test 1, Flammability, Odor, Offgassing, and Compatibility Requirements and Test Procedures for Materials in Environments that Support Combustion. The material shall be evaluated in the worst-case use environment at the worst-case use configuration. When the use of a nonflammable material is not possible, a Material Usage Agreement (MUA) or equivalent shall be submitted to the cognizant NASA center for disposition. If test data does not exist for a material, the experimenter may be asked to provide samples (see NASA-STD-6001, Chapter 4) to a NASA certified test facility such as Marshall Space Flight Center (MSFC) or White Sands Test Facility (WSTF) for flammability testing).

Materials transported or operated in the orbiter cabin, or operated in the ISS air lock during Extravehicular Activity (EVA) preparations, shall be tested and evaluated for flammability in the worst-case use environment of 30% oxygen and 10.2 psia. Materials used in all other habitable areas shall be tested and evaluated in the worst-case use environment of 24.1% oxygen and 15.2 psia. (LS-71000, Section 5.4.1.1.8)

4.3.6 Offgassing

All flight hardware located in habitable areas shall be subjected to test and meet the toxicity offgassing acceptance requirements of NASA-STD-6001, Test 7. (LS-71000, Section 5.4.1.1.9)

4.3.7 Bench Handling

A bench handling test shall be performed on the qualification unit for all hardware. The bench handling test shall be conducted in accordance with MIL-STD-810, Section 516.4, I3.6, Procedure 4 or 6 with the following modifications: Test conditions of 26 drops altered to two (2) drops. Surfaces, corners, edges shall be identified in the test procedure. (LS-71000, Section 5.4.1.1.5)

4.3.8 Payload Mass

The JES shall comply with LS-71014, Mass Properties Control Plan Human Research Facility Payload and Racks (draft). (LS-71000, Section 5.4.1.1.1)

4.3.9 Electromagnetic Compatibility

The JES shall comply with LS-71016, Electromagnetic Compatibility Control Plan for the Human Research Facility. (LS-71000, Section 5.4.1.2.1)

4.3.10 Acoustic Noise

The JES shall comply with LS-71011, Acoustic Noise Control and Analysis Plan for Human Research Facility Payloads and Racks. (LS-71000, Section 5.4.1.1.7)

4.3.11 Pre-Delivery Acceptance

The responsible manufacturing parties shall perform a Pre-Delivery Acceptance (PDA) after the complete fabrication and assembly has been conducted for all Class I deliverable assemblies. This test shall include verification of software interface and operation. The PDA must be completed before hardware certification testing begins. It is a full functional test and inspection that validates that the hardware operates per the design requirements and that it is constructed per released engineering drawings. All PDA tests shall be approved by the hardware's JSC technical monitor and JSC/NT3, as well as the contractor quality engineering (if applicable). The following are standard steps that each PDA test shall contain:

1. Conformance to Drawing. Verify that the hardware conforms to released engineering drawings.

2. No Sharp Edges. Inspect the hardware to verify that there are no sharp edges or corners present.

3. Proper Identifying Markings. Verify that the hardware has the proper part number and serial number (if applicable) on it.

4. Cleanliness. All PDA tests shall include verification that all surfaces (external, internal, etc.) are to the cleanliness level of Section 3.3.1.1C of this document.

## 5.0 PREPARATION FOR SHIPMENT

### 5.1 General

A. The methods of preservation, packaging, and packing used for shipment, together with necessary special control during transportation, shall adequately protect the article(s) from damage or degradation in reliability or performance as a result of the natural and induced environments encountered during transportation and subsequent indoor storage. (LS-71000, Section 9.1A)

B. To reduce program cost, prior to developing a newly designed container, every effort will be made by project participants to use container designs and/or containers available commercially or from Government inventories. If reusable containers are not available, a screening process should be initiated for container availability in the following priority: existing containers, commercial off-the-shelf containers, and modified commercial off-the shelf containers. Shipping containers and protective devices will be designed for effective and economical manufacture, procurement, and transportability. (LS-71000, Section 9.1B)

### 5.2 Packing, Handling, and Transportation

A. Packaging, handling, and transportation shall be in accordance with applicable requirements of NHB 6000.1C, and referenced documents therein. (LS-71000, Section 9.2A)

B. Documented procedures and physical controls shall be established to ensure that the HRF rack and individual items of equipment will not be subjected to temperature, shock, and humidity outside the non-operational limits during shipment. (LS-71000, Section 9.2C)

C. The JES shall be cleaned to the "Visibly Clean Level 1 (Sensitive)" as determined in SN-C-0005, Specification Contamination Control Requirements for the Shuttle Program. (LS-71000, Section 9.2D)

### 5.3 Preservation and Packing

Preservation and packing shall be in accordance with approved Packaging, Handling, and Transportation Records (PHTRs). (LS-71000, Section 9.3)

### 5.4 Marking for Shipment

Interior and exterior containers shall be marked and labeled in accordance with NHB 6000.1C, including precautionary markings necessary to ensure safety of personnel and facilities, and to ensure safe handling, transport, and storage. Should the individual items of equipment contain any hazardous materials,

markings shall also comply with applicable requirements governing packaging and labeling of hazard materials. Packages with reuse capability shall be identified with the words “Reusable Container - Do Not Destroy - Retain for Reuse.” NASA Critical Item Labels (Form 1368 series) shall be applied in accordance with NHB 6000.1C. (LS-71000, Section 9.4)

5.5 NASA Critical Space Item Label

The NASA Critical Space Item Labels Form 1368 shall be affixed to exterior and interior shipping containers in accordance with NHB 6000.1C. (LS-71000, Section 9.5A)

## 6.0 NOTES

This section contains information of a general or explanatory nature that may be helpful but is not mandatory.

### 6.1 Definitions

| | |
|---|---|
| Qualification Test | Test conducted as part of the certification program to demonstrate that the design and performance requirements can be realized under specified conditions. |
| Acceptance Test | Formal tests conducted to assure that the end item meets specified requirements. Acceptance tests include performance demonstrations and environmental exposures to screen out manufacturing defects, workmanship errors, incipient failures, and other performance anomalies not readily detectable by normal inspection techniques or through ambient functional tests. |
| Active Air Exchange | Forced convection between two volumes. For example, forced convection between a subrack payload and the internal volume of an integrated rack, or forced convection between a subrack payload and cabin air. |
| Continuous Noise Source | A significant noise source which exists for a cumulative total of eight hours or more in any 24-hour period is considered to be a continuous noise source. |
| Intermittent Noise Source | A significant noise source which exists for a cumulative total of less than eight hours in a 24-hour period is considered to be an intermittent noise source. |

# APPENDIX A
# RESERVED

# APPENDIX B

# ISS PRESSURIZED PAYLOAD INTERFACE REQUIREMENTS DOCUMENT VERIFICATION MATRIX

# APPENDIX B

## ISS PRESSURIZED PAYLOAD INTERFACE REQUIREMENTS DOCUMENT VERIFICATION MATRIX

| SRD Section | LS-71000 Section | SSP 57000 Section | Requirement | Applicable | GPVP VDS # | Responsibility | Comments |
|---|---|---|---|---|---|---|---|
| 3.2.2.2.2.1.A | 6.3.1.5A | 3.1.1.7.A | On-Orbit Payload Protrusions | N/A | ME-059 | | Crew worn hardware. |
| 3.2.2.2.2.1.B | 6.3.1.5B | 3.1.1.7.B | On-Orbit Payload Protrusions | N/A | ME-059 | | Crew worn hardware. |
| 3.2.2.2.2.1.1 | 6.3.1.5.1 | 3.1.1.7.1 | On-Orbit Permananet Protrusions | N/A | ME-059 | | Crew worn hardware. |
| 3.2.2.2.2.1.2A | 6.3.1.5.2A | 3.1.1.7.2.A | On-Orbit Semi-Permanent Protrusions | N/A | ME-059 | | Crew worn hardware. |
| 3.2.2.2.2.1.2B | 6.3.1.5.2B | 3.1.1.7.2.B | On-Orbit Semi-Permanent Protrusions | N/A | ME-059 | | Crew worn hardware. |
| 3.2.2.2.2.1.3A | 6.3.1.5.3A | 3.1.1.7.3.A | On-Orbit Semi-Permanent Protrusions | N/A | ME-059 | | Crew worn hardware. |
| 3.2.2.2.2.1.3B | 6.3.1.5.3B | 3.1.1.7.3.B | On-Orbit Semi-Permanent Protrusions | N/A | ME-059 | | Crew worn hardware. |
| 3.2.2.2.2.1.4 | 6.3.1.5.4 | 3.1.1.7.4 | On-Orbit Momentary Protrusions | N/A | ME-059 | | Crew worn hardware. |
| 3.2.4A | 6.4.4.2.6.3 | 3.12.4.2.8.4 | Maintainability - Unique Tools | ✓ | ME-016 | | |
| 3.2.4B | 6.4.4.3.1 | 3.12.4.3.1 | Maintainability - One-handed Operation | N/A | ME-017 | | |
| 3.2.4C | 6.4.4.3.2B | 3.12.4.3.2A2 | Maintainability - Connector Mate/Demate | N/A | ME-018 | | |
| 3.2.4D | 6.4.4.3.2C | 3.12.4.3.2B | Maintainability - No Damage to Wiring Connectors | ✓ | ME-018 | | |
| 3.2.4E | 6.4.4.2.6 | 3.12.4.2.8 | Maintainability - Access to Hardware Items | N/A | ME-042 | | |
| 3.2.4F | 6.4.3.1.2A | 3.12.3.1.2A | Maintainability - Built-in Control | N/A | ME-008 | | |
| 3.2.4G | 6.4.3.1.2B | 3.12.3.1.2B | Maintainability - Access to Filters for Replacement/Cleaning | N/A | ME-008 | | |
| 3.2.4.1.1 | 6.4.10 | 3.12.10 | Payload In-flight Maintenance | N/A | ME-003 | | |
| 3.2.5.1.1.1 | 6.3.6.1.1 | 3.9.1.1 | Pressure | ✓ | Safety | | |
| 3.2.5.1.1.2 | 6.3.6.1.2 | 3.9.1.2 | Temperature | ✓ | Safety | | |
| 3.2.5.1.1.3 | 6.3.6.1.3 | 3.9.1.3 | Humidity | N/A | EN-001 | | |
| 3.2.5.1.2.1 | 6.3.6.2.1 | 3.9.2.1A | Active Air Exchange | N/A | EN-002 | | |

✓ - Requirement is applicable E - Exception N/A - Requirement is not applicable

APPENDIX B

ISS PRESSURIZED PAYLOAD INTERFACE REQUIREMENTS DOCUMENT VERIFICATION MATRIX

| SRD Section | LS-71000 Section | SSP 57000 Section | Requirement | Applicable | GPVP VDS # | Responsibility | Comments |
|---|---|---|---|---|---|---|---|
| 3.2.5.1.2.3 | 6.3.6.2.3 | 3.9.2.3 | Chemical Releases | ✓ | Safety | | |
| 3.2.5.1.2.5 | 6.3.4.3 | 3.5.1.13 | Cabin Air Cooling | N/A | FD-009 | | |
| 3.2.5.1.3.1 | 6.3.6.3.1 | 3.9.3.1 | Instrument Contained or Generated Ionizing Radiation | N/A | Safety | | |
| 3.2.5.1.3.3 | 6.3.6.3.3 | 3.9.3.3 | Single Event Effect (SEE) Ionizing Radiation | ✓ | EN-004 | | |
| 3.2.5.1.5A | 6.3.1.2B | 3.1.1.4B | Pressure Rate of Change - On-orbit | ✓ | ST-003 | | |
| 3.2.5.1.5C1 | 6.3.1.2A | 3.1.1.2B | Pressure Rate of Change - MPLM | ✓ | ST-003 | | |
| 3.2.5.1.5D | 6.3.1.2C | 3.1.1.4K | Pressure Rate of Change - PFE | N/A | ST-003 | | |
| 3.2.5.2.1 | 6.4.3.3.1C | 3.12.3.3.1C | Continuous Noise Limits | N/A | EN-006 | | |
| 3.2.5.2.2A | 6.4.3.3.2A | 3.12.3.3.2A | Intermittent Noise Limits - A-weighted SPL Limits | N/A | EN-006 | | |
| 3.2.5.2.2B | 6.4.3.3.2 | 3.12.3.3.2B | Intermittent Noise Limits - Cumulative Duration | N/A | EN-006 | | |
| 3.2.5.3 | 6.3.4.1 | 3.5.1.11 | Instrument Surface Temperature | N/A | FD-032 | | |
| 3.2.7.1.1 | | 3.1.1.6.1 | Connector Physical Mate | N/A | EL-007 ME-056 | | |
| 3.2.7.2.1.1 | 6.3.2.4 | 3.2.4 | Electromagnetic Compatibility (EMC) | N/A | EL-020 | | |
| 3.2.7.2.1.1.1 | 6.3.2.4.1 | 3.2.4.1 | Electrical Grounding | N/A | EL-021 | | |
| 3.2.7.2.1.1.2 | 6.3.2.4.2 | 3.2.4.2 | Electrical Bonding | N/A | EL-022 | | |
| 3.2.7.2.1.2A | 6.3.2.4.4 | 3.2.4.4 | Electromagnetic Interference | ✓ | EL-020 | | |
| 3.2.7.2.1.2B | 6.3.2.4.4 | 3.2.4.4 | Electromagnetic Interference - Alternative Use of RS03PL | ✓ | EL-020 | | |
| 3.2.7.2.2A | 6.3.2.5 | 3.2.4.5 | ESD ≤ 4000V | ✓ | EL-024 | | |
| 3.2.7.2.2B | 6.3.2.5 | 3.2.4.5 | ESD between 4000V and 15000V - Labeling EPCE | ✓ | EL-024 | | |
| 3.2.7.2.2C | 6.3.2.5 | 3.2.4.5 | ESD Labeling | ✓ | EL-024 | | |
| 3.2.7.2.3 | 6.3.2.8 | 3.2.4.8 | Corona | ✓ | EL-024 | | |

✓ - Requirement is applicable E - Exception N/A - Requirement is not applicable

# APPENDIX B

## ISS PRESSURIZED PAYLOAD INTERFACE REQUIREMENTS DOCUMENT VERIFICATION MATRIX

| SRD Section | LS-71000 Section | SSP 57000 Section | Requirement | Applicable | GPVP VDS # | Responsibility | Comments |
|---|---|---|---|---|---|---|---|
| 3.2.7.2.4 | 6.3.2.4.3 | 3.2.4.3 | Cable/Wire Design and Control Requirements | N/A | EL-021 | | |
| 3.2.7.2.4.1B | 6.3.2.1B | 3.2.3.1B | Wire Derating | N/A | EL-017 | | |
| 3.2.7.2.4.2 | 6.3.2.2 | 3.2.3.2B | Exclusive Power Feeds | N/A | EL-018 | | |
| 3.2.7.2.5 | 6.3.2.3 | 3.2.3.3 | Loss of Power | N/A | Safety | | |
| 3.2.7.2.6 | 6.3.2.6 | 3.2.4.6 | AC Magnetic Fields | ✓ | EL-020 | | |
| 3.2.7.2.7 | 6.3.2.7 | 3.2.4.7 | DC Magnetic Fields | ✓ | EL-020 | | |
| 3.2.7.3.1.1 | 6.3.3.1.1 | 3.3.2.1 | Word/Byte Notations | ✓ | CD-001 | | |
| 3.2.7.3.1.2 | 6.3.3.1.2 | 3.3.2.2 | Data Types | ✓ | CD-001 | | |
| 3.2.7.3.2C(1) | 6.3.3.2D | 3.3.8.1C | HRF Software Requirements - DGCS | N/A | | | |
| 3.2.7.4.1 | 6.3.7.1 | 3.10.1 | Fire Prevention | ✓ | Safety | | |
| 3.2.7.4.2.1A | 6.3.7.2.1A | 3.10.3.1A | PFE - Small Access Port | N/A | ME-055 | | |
| 3.2.7.4.2.1B | 6.3.7.2.1B | 3.10.3.1B | PFE - Large Access Port | N/A | ME-055 | | |
| 3.2.7.4.2.2 | 6.3.7.2.2 | 3.10.3.2 | Fire Suppression Access Port Accessibility | N/A | ME-055 | | |
| 3.2.7.4.2.3 | 6.3.7.2.3 | 3.10.3.3 | Fire Suppressant Distribution | N/A | ME-055 | | |
| 3.2.7.4.3 | 6.3.7.3 | 3.10.4A | Labeling | N/A | ME-055 | | |
| 3.3.1.1A | 6.3.8.1 | 3.11.1 | Materials and Processes | ✓ | Safety | | |
| 3.3.1.1B | 6.3.8.2 | 3.11.1.1 | Materials and Processes - Commercial Parts | ✓ | Safety | | |
| 3.3.1.1C | 6.3.8.3 | 3.11.3 | Materials and Processes - Cleanliness | ✓ | MP-002 | | |
| 3.3.1.1D | 6.4.3.1.4 | 3.12.3.1.6 | Materials and Processes - Surface Materials | N/A | MP-004 | | |
| 3.3.1.1E | 6.3.8.4 | 3.11.4 | Materials and Processes - Fungus Resistant Materials | ✓ | MP-003 | | |
| 3.3.1.2 | 6.4.9.2 | 3.12.9.2 | Sharp Edges and Corner Protection | ✓ | Safety | | |
| 3.3.1.3 | 6.4.9.3 | 3.12.9.3 | Holes | N/A | ME-007 | | |
| 3.3.1.4 | 6.4.9.4 | 3.12.9.4 | Latches | N/A | ME-027 | | |
| 3.3.1.5 | 6.4.9.5 | 3.12.9.5 | Screws and Bolts | ✓ | ME-026 | | |
| 3.3.1.6 | 6.4.9.6 | 3.12.9.6 | Securing Pins | N/A | ME-053 | | |

✓ - Requirement is applicable E - Exception N/A - Requirement is not applicable

APPENDIX B

ISS PRESSURIZED PAYLOAD INTERFACE REQUIREMENTS DOCUMENT VERIFICATION MATRIX

| SRD Section | LS-71000 Section | SSP 57000 Section | Requirement | Applicable | GPVP VDS # | Responsibility | Comments |
|---|---|---|---|---|---|---|---|
| 3.3.1.7 | 6.4.9.7 | 3.12.9.7 | Levers, Cranks, Hooks, and Controls | N/A | ME-053 | | |
| 3.3.1.8 | 6.4.9.8 | 3.12.9.8 | Burrs | ✓ | ME-053 | | |
| 3.3.1.9A | 6.4.9.9A | 3.12.9.9A | Locking Wires | N/A | ST-009 | | |
| 3.3.1.9B | 6.4.9.9B | 3.12.9.9B | Locking Wires - Safety Cabling or Cotter Pinning | N/A | ST-009 | | |
| 3.3.2.1 | 6.4.7 | 3.12.7 | Equipment Identification | ✓ | ME-057 | | |
| 3.3.5.1.1A | 6.3.2.10.1 | 3.2.5.1.1 | Mating/Demating of Powered Connectors | ✓ | Safety | | |
| 3.3.5.1.2A | 6.3.2.10.3A | 3.2.5.3A | Power Switches/Controls - Open Supply Circuit Conductors | ✓ | EL-029 | | |
| 3.3.5.1.2B | 6.3.2.10.3B | 3.2.5.3B | Power Switches/Controls - Power-off Markings/Indications | ✓ | EL-029 | | |
| 3.3.5.1.2C | 6.3.2.10.3C | 3.2.5.3C | Power Switches/Controls - Supply Circuit not Completely Disconnected | ✓ | EL-029 | | |
| 3.3.5.1.3A | 6.3.2.10.4A | 3.2.5.4A | GFCI - Output Voltages > 30 V rms | N/A | EL-030 | | |
| 3.3.5.1.3B | 6.3.2.10.4B | 3.2.5.4B | GFCI - DC Detection Independent of Safety Wire | N/A | EL-030 | | |
| 3.3.5.1.3C | 6.3.2.10.4C | 3.2.5.4C | GFCI - AC Detection Dependent on Safety Wire | N/A | EL-030 | | |
| 3.3.5.1.3D | 6.3.2.10.4D | 3.2.5.4D | GFCI - HARDWARE Generating Internal Voltages > 30 V rms | N/A | EL-030 | | |
| 3.3.5.1.3E | 6.3.2.10.4E | 3.2.5.4E | GFCI - Trip Current | N/A | EL-030 | | |
| 3.3.5.1.3F | 6.3.2.10.4F | 3.2.5.4F | GFCI - Power Removal Time | N/A | EL-030 | | |
| 3.3.5.1.3G | 6.3.2.10.4G | 3.2.5.4G | GFCI - On-Orbit Testing | N/A | EL-030 | | |
| 3.3.5.1.4A | 6.3.2.10.5A | 3.2.5.5A | Portable Equipment/Power Cords - Non-battery Powered Portable HARDWARE | N/A | EL-031 | | |
| 3.3.5.1.4B | 6.3.2.10.5B | 3.2.5.5B | Portable Equipment/Power Cords - Fault Currents | N/A | EL-031 | | |

✓ - Requirement is applicable E - Exception N/A - Requirement is not applicable

APPENDIX B

ISS PRESSURIZED PAYLOAD INTERFACE REQUIREMENTS DOCUMENT VERIFICATION MATRIX

| SRD Section | LS-71000 Section | SSP 57000 Section | Requirement | Applicable | GPVP VDS # | Responsibility | Comments |
|---|---|---|---|---|---|---|---|
| 3.3.6.1 | 6.4.3.1.1 | 3.12.3.1.1 | Closures or Covers Design Requirements | ✓ | ME-007 | | |
| 3.3.6.3A | 6.4.2.3 | 3.12.2.3 | Full Size Range Accommodation | ✓ | ME-006 | | |
| 3.3.6.4A | 6.4.1.1A | 3.12.1A1 | Grip Strength | ✓ | ST-005 | | |
| 3.3.6.4B | 6.4.1.1B | 3.12.1A2 | Linear Forces | ✓ | ST-005 | | |
| 3.3.6.4C | 6.4.1.1C | 3.12.1A3 | Torque | ✓ | ST-005 | | |
| 3.3.6.5 | 6.4.1.2 | 3.12.1B | Maintenance Operations | N/A | ST-005 | | |
| 3.3.6.6 | 6.4.2.1 | 3.12.2.1 | Adequate Clearance | N/A | ME-021 | | |
| 3.3.6.7A | 6.4.2.2A | 3.12.2.2A | Accessibility - Geometric Arrangement | ✓ | ME-021 | | |
| 3.3.6.7B | 6.4.2.2B | 3.12.2.2B | Accessibility - Access Openings for Fingers | ✓ | ME-021 | | |
| 3.3.6.8 | 6.4.3.1.3 | 3.12.3.1.5 | One-Handed Operation | N/A | ME-009 | | |
| 3.3.6.9 | 6.4.3.2.1 | 3.12.3.2.1 | Continuous/Incidental Contact - High Temperature | ✓ | Safety | | |
| 3.3.6.10 | 6.4.3.2.2 | 3.12.3.2.2 | Continuous/Incidental Contact - Low Temperature | N/A | Safety | | |
| 3.3.6.11 | 6.4.4.2.1 | 3.12.4.2.1 | Equipment Mounting | ✓ | ME-011 | | |
| 3.3.6.12A | 6.4.4.2.2A | 3.12.4.2.2 | Drawers and Hinged Panels - for routine checkout of P/L ORUs | N/A | ME-012 | | |
| 3.3.6.12B | 6.4.4.2.2B | 3.12.4.2.2 | Drawers and Hinged Panels - remain open without manual support | N/A | ME-012 | | |
| 3.3.6.13 | 6.4.4.2.3 | 3.12.4.2.5 | Alignment | N/A | ME-013 | | |
| 3.3.6.14 | 6.4.4.2.5 | 3.12.4.2.7 | Push-Pull Force | N/A | ST-006 | | |
| 3.3.6.15A | 6.4.4.2.6.1A | 3.12.4.2.8.1A | Covers - sliding or hinged cap or door | ✓ | ME-007 | | |
| 3.3.6.15B | 6.4.4.2.6.1B | 3.12.4.2.8.1B | Covers - quick-opening cover plate | ✓ | ME-007 | | |
| 3.3.6.16 | 6.4.4.2.6.2 | 3.12.4.2.8.2 | Self-Supporting Covers | ✓ | ME-007 | | |
| 3.3.6.17 | 6.4.4.3.2A | 3.12.4.3.2A1 | Accessibility | ✓ | ME-018 | | |
| 3.3.6.18 | 6.4.4.3.3 | 3.12.4.3.3 | Ease of Disconnect | ✓ | ME-017 | | |

✓ - Requirement is applicable E - Exception N/A - Requirement is not applicable

APPENDIX B

ISS PRESSURIZED PAYLOAD INTERFACE REQUIREMENTS DOCUMENT VERIFICATION MATRIX

| SRD Section | LS-71000 Section | SSP 57000 Section | Requirement | Applicable | GPVP VDS # | Responsibility | Comments |
|---|---|---|---|---|---|---|---|
| 3.3.6.19 | 6.4.4.3.5 | 3.12.4.3.5 | Self Locking | ✓ | ME-017 | | |
| 3.3.6.20A | 6.4.4.3.6A | 3.12.4.3.6A | Connector Arrangement - Space between Connectors and Adjacent Obstructions | ✓ | ME-018 | | |
| 3.3.6.20B | 6.4.4.3.6B | 3.12.4.3.6B | Connector Arrangement - Space between Connectors in a Row | ✓ | ME-018 | | |
| 3.3.6.21 | 6.4.4.3.7 | 3.12.4.3.7 | Arc Containment | ✓ | EL-026 | | |
| 3.3.6.22 | 6.4.4.3.8 | 3.12.4.3.8 | Connector Protection | ✓ | ME-019 | | |
| 3.3.6.23 | 6.4.4.3.9 | 3.12.4.3.9 | Connector Shape | ✓ | ME-019 | | |
| 3.3.6.24 | 6.4.4.3.11 | 3.12.4.3.11A | Alignment Marks or Guide Pins | ✓ | ME-020 | | |
| 3.3.6.25A | 6.4.4.3.12A | 3.12.4.3.12A | Coding - Unique to Connection | ✓ | ME-020 | | |
| 3.3.6.25B | 6.4.4.3.12B | 3.12.4.3.12B | Coding - Visible | ✓ | ME-020 | | |
| 3.3.6.26 | 6.4.4.3.13 | 3.12.4.3.13 | Pin Identification | ✓ | EL-007 | | |
| 3.3.6.27 | 6.4.4.3.14 | 3.12.4.3.14 | Orientation | ✓ | ME-020 | | |
| 3.3.6.28A | 6.4.4.3.15A | 3.12.4.3.15A | Hose/Cable Restraints - Loose Ends | N/A | ME-022 | | |
| 3.3.6.28B | 6.4.4.3.15B | 3.12.4.3.15B | Hose/Cable Restraints - Clamps | N/A | ME-022 | | |
| 3.3.6.28D | 6.4.4.3.15D | 3.12.4.3.15D | Hose/Cable Restraints - Lengths | ✓ | ME-022 | | |
| 3.3.6.29 | 6.4.4.4.1 | 3.12.4.4.1 | Non-Threaded Fasteners Status Indication | N/A | ME-023 | | |
| 3.3.6.30 | 6.4.4.4.2 | 3.12.4.4.2 | Mounting Bolt/Fastener Spacing | N/A | ME-024 | | |
| 3.3.6.31 | 6.4.4.4.3 | 3.12.4.4.4A | Multiple Fasteners | ✓ | ME-025 | | |
| 3.3.6.32 | 6.4.4.4.4 | 3.12.4.4.5 | Captive Fasteners | ✓ | ME-026 | | |
| 3.3.6.33A | 6.4.4.4.5A | 3.12.4.4.6A | Quick Release Fasteners - One turn max | N/A | ME-026 | | |
| 3.3.6.33B | 6.4.4.4.5B | 3.12.4.4.6B | Quick Release Fasteners - Positive Locking | N/A | ME-026 | | |
| 3.3.6.34 | 6.4.4.4.6 | 3.12.4.4.7 | Threaded Fasteners | ✓ | ME-026 | | |

✓ - Requirement is applicable E - Exception N/A - Requirement is not applicable

APPENDIX B

ISS PRESSURIZED PAYLOAD INTERFACE REQUIREMENTS DOCUMENT VERIFICATION MATRIX

| SRD Section | LS-71000 Section | SSP 57000 Section | Requirement | Applicable | GPVP VDS # | Responsibility | Comments |
|---|---|---|---|---|---|---|---|
| 3.3.6.35A | 6.4.4.4.7A | 3.12.4.4.8A | Over Center Latches - Nonself-latching | N/A | ME-027 | | |
| 3.3.6.35B | 6.4.4.4.7B | 3.12.4.4.8B | Over Center Latches - Latch Lock | N/A | ME-027 | | |
| 3.3.6.35C | 6.4.4.4.7C | 3.12.4.4.8C | Over Center Latches - Latch Handles | N/A | ME-027 | | |
| 3.3.6.36 | 6.4.4.4.8 | 3.12.4.4.9 | Winghead Fasteners | N/A | ME-026 | | |
| 3.3.6.37A | 6.4.4.4.9A | 3.12.4.4.11A | Fastener Head Type - On-Orbit Crew Actuation | ✓ | ME-028 | | |
| 3.3.6.37B | 6.4.4.4.9B | 3.12.4.4.11B | Fastener Head Type - Smooth Surface | ✓ | ME-028 | | |
| 3.3.6.37C | 6.4.4.4.9C | 3.12.4.4.11C | Fastener Head Type - Slotted Fasteners | N/A | ME-028 | | |
| 3.3.6.38 | 6.4.4.4.10 | 3.12.4.4.12 | One-Handed Actuation | ✓ | ME-029 | | |
| 3.3.6.39 | 6.4.4.4.11 | 3.12.4.4.13 | Accessibility | ✓ | ME-024 | | |
| 3.3.6.40 | 6.4.4.4.12 | 3.12.4.4.14 | Access Holes | N/A | ME-024 | | |
| 3.3.6.41 | 6.4.5.1 | 3.12.5.1 | Controls Spacing Design Requirements | ✓ | ME-030 | | |
| 3.3.6.42A | 6.4.5.2.1A | 3.12.5.2.1A | Protective Methods - Location/Orientation | ✓ | ME-031 | | |
| 3.3.6.42B | 6.4.5.2.1B | 3.12.5.2.1B | Protective Methods - Recess/Shielding | ✓ | ME-031 | | |
| 3.3.6.42C | 6.4.5.2.1C | 3.12.5.2.1C | Protective Methods - Cover/Guard, No Safety or Lock Wire | ✓ | ME-031 | | |
| 3.3.6.42D | 6.4.5.2.1D | 3.12.5.2.1D | Protective Methods - Obscuration by Cover Guards | ✓ | ME-031 | | |
| 3.3.6.42E | 6.4.5.2.1E | 3.12.5.2.1E | Protective Methods - Interlocks | ✓ | ME-031 | | |
| 3.3.6.42F | 6.4.5.2.1F | 3.12.5.2.1F | Protective Methods - Resistance | ✓ | ME-031 | | |
| 3.3.6.42G | 6.4.5.2.1G | 3.12.5.2.1G | Protective Methods - Position Locks for Sequencing | ✓ | ME-031 | | |
| 3.3.6.43 | 6.4.5.2.2 | 3.12.5.2.2 | Noninterference | ✓ | ME-030 | | |

✓ - Requirement is applicable E - Exception N/A - Requirement is not applicable

APPENDIX B

ISS PRESSURIZED PAYLOAD INTERFACE REQUIREMENTS DOCUMENT VERIFICATION MATRIX

| SRD Section | LS-71000 Section | SSP 57000 Section | Requirement | Applicable | GPVP VDS # | Responsibility | Comments |
|---|---|---|---|---|---|---|---|
| 3.3.6.44 | 6.4.5.2.3 | 3.12.5.2.3 | Dead-Man Controls | N/A | Safety | | |
| 3.3.6.45 | 6.4.5.2.4 | 3.12.5.2.4 | Barrier Guards | N/A | ME-030 | | |
| 3.3.6.46 | 6.4.5.2.5 | 3.12.5.2.5 | Recessed Switch Protection | N/A | ME-031 | | |
| 3.3.6.47 | 6.4.5.2.7 | 3.12.5.2.7 | Position Indication | ✓ | ME-032 | | |
| 3.3.6.48 | 6.4.5.2.8 | 3.12.5.2.8 | Hidden Controls | N/A | ME-031 | | |
| 3.3.6.49 | 6.4.5.2.9 | 3.12.5.3.9 | Hand Controllers | N/A | ME-031 | | |
| 3.3.6.50A | 6.4.5.3A | 3.12.5.3A | Valve Controls - Low-Torque Valves | N/A | ME-033 | | |
| 3.3.6.50B | 6.4.5.3B | 3.12.5.3B | Valve Controls - Intermediate-Torque Valves | N/A | ME-033 | | |
| 3.3.6.50C | 6.4.5.3C | 3.12.5.3C | Valve Controls - High-Torque Valves | N/A | ME-033 | | |
| 3.3.6.50D | 6.4.5.3D | 3.12.5.3D | Valve Controls - Handle Dimensions | N/A | ME-033 | | |
| 3.3.6.50E | 6.4.5.3E | 3.12.5.3E | Valve Controls - Rotary Valve Controls | N/A | ME-033 | | |
| 3.3.6.51 | 6.4.5.4 | 3.12.5.4 | Toggle Switches | N/A | ME-034 | | |
| 3.3.6.52 | 6.4.6 | 3.12.6 | Restraints and Mobility Aids | ✓ | ME-035 | | |
| 3.3.6.54 | 6.4.6.3 | 3.12.6.3 | Captive Parts | ✓ | N/A | | |
| 3.3.6.55 | 6.4.6.4.1 | 3.12.6.4.1 | Handles and Restraints | N/A | ME-037 | | |
| 3.3.6.56 | 6.4.6.4.2 | 3.12.6.4.3 | Handle Location/Front Access | N/A | ME-037 | | |
| 3.3.6.57 | 6.4.6.4.3 | 3.12.6.4.4 | Handle Dimensions | N/A | ME-037 | | |
| 3.3.6.58A | 6.4.6.4.4A | 3.12.6.4.5A | Non-Fixed Handles Design Requirements - Stop Position | N/A | ME-037 | | |
| 3.3.6.58B | 6.4.6.4.4B | 3.12.6.4.5B | Non-Fixed Handles Design Requirements - One Hand Use | N/A | ME-037 | | |
| 3.3.6.58C | 6.4.6.4.4C | 3.12.6.4.5C | Non-Fixed Handles Design Requirements - Locked/Unlocked Indication | N/A | ME-037 | | |
| 3.3.6.59B | 6.4.9.1B | 3.12.9.1B | Electrical Hazards - Exposure hazard exceeds threshold for shock | N/A | EL-041 | | |

✓ - Requirement is applicable E - Exception N/A - Requirement is not applicable

APPENDIX B

ISS PRESSURIZED PAYLOAD INTERFACE REQUIREMENTS DOCUMENT VERIFICATION MATRIX

| SRD Section | LS-71000 Section | SSP 57000 Section | Requirement | Applicable | GPVP VDS # | Responsibility | Comments |
|---|---|---|---|---|---|---|---|
| 3.3.6.59C | 6.4.9.1C | 3.12.9.1C | Electrical Hazards - Exposure hazard exceeds threshold for shock and threshold of let-go profile | N/A | EL-041 | | |
| 3.3.6.59D | 6.4.9.1D | 3.12.9.1D | Electrical Hazards -Two dependent controls provided | N/A | EL-041 | | |
| 3.3.6.59E | 6.4.9.1E | 3.12.9.1E | Electrical Hazards -Three independent hazard controls | N/A | EL-041 | | |
| 3.3.6.60A | 6.4.9.1.1A | 3.12.9.1.1 | Mismatched - Reversed Connection | ✓ | ME-019 | | |
| 3.3.6.60B | 6.4.9.1.1B | 3.12.9.1.1 | Mismatched - Blind Connections | ✓ | ME-019 | | |
| 3.3.6.60C | 6.4.9.1.1C | 3.12.9.1.1 | Mismatched - Mismating | ✓ | ME-019 | | |
| 3.3.6.60D | 6.4.9.1.1D | 3.12.9.1.1 | Mismatched -Minimizing Equipment Risk | ✓ | ME-019 | | |
| 3.3.6.61 | 6.4.9.1.2.1 | 3.12.9.1.4.1 | Device Accessibility | ✓ | EL-013 | | |
| 3.3.6.62 | 6.4.9.1.2.2 | 3.12.9.1.4.2 | Extractor-Type Fuse Holder | ✓ | EL-013 | | |
| 3.3.6.63 | 6.4.9.1.2.3 | 3.12.9.1.4.3 | Overload Protection Location | ✓ | EL-013 | | |
| 3.3.6.64 | 6.4.9.1.2.4 | 3.12.9.1.4.4 | Overload Protection Identification | ✓ | EL-013 | | |
| 3.3.6.65 | 6.4.9.1.2.5 | 3.12.9.1.4.5 | Automatic Restart Protection | ✓ | EL-013 | | |
| 3.3.6.66A | 6.4.9.10A | 3.12.9.10A | Audio Displays - False Alarms | N/A | ME-044 | | |
| 3.3.6.66B | 6.4.9.10C | 3.12.9.10C | Audio Displays - Operability Testing | N/A | ME-044 | | |
| 3.3.6.66C | 6.4.9.10D | 3.12.9.10D | Audio Displays - Manual Disable | N/A | ME-044 | | |
| 3.3.6.67 | 6.4.9.11 | 3.12.9.12 | Egress | ✓ | Safety | | |
| 3.3.8.1A1 | 6.3.1.3.A | 3.1.1.3A | Structural Design Requirements - Positive Margins of Safety for MPLM Launch & Landing | N/A | ST-001 | | |

✓ - Requirement is applicable E - Exception N/A - Requirement is not applicable

# APPENDIX B

## ISS PRESSURIZED PAYLOAD INTERFACE REQUIREMENTS DOCUMENT VERIFICATION MATRIX

| SRD Section | LS-71000 Section | SSP 57000 Section | Requirement | Applicable | GPVP VDS # | Responsibility | Comments |
|---|---|---|---|---|---|---|---|
| 3.3.8.1B | 6.3.1.3B | 3.1.1.3B | Structural Design Requirements - Positive Safety Margins for On-orbit Loads | ✓ | ST-001 | | |
| 3.3.8.1.1 | 6.3.1.3C | 3.1.1.3D | Crew Induced Load Requirements | ✓ | ST-002 | | |
| 3.3.8.1.2 | 6.3.1.1 | 3.1.1.5A | Safety Critical Structures Requirements | N/A | ST-001<br>ST-002<br>ST-003<br>ST-004<br>ST-008<br>ST-009<br>ST-010 | | |
| 3.3.8.3.1 | 6.2.7.2 | 3.7.5 | Pressurized Gas Bottles | N/A | FD-028 | | |
| 3.3.8.3.2 | 6.2.7.3 | 3.7.6 | Manual Valves | N/A | ME-048 | | |

✓ - Requirement is applicable E - Exception N/A - Requirement is not applicable

# APPENDIX C

# FUNCTIONAL PERFORMANCE VERIFICATION MATRIX

# APPENDIX C

## FUNCTIONAL PERFORMANCE VERIFICATION MATRIX

| SRD Section | LS-71000 Section | Requirement | Applicable | **Comments** |
|---|---|---|---|---|
| 3.2.1.1.1 | | Number of Data Channels | ✓ | |
| 3.2.1.1.2 | | Display Parameters – Angle Data | ✓ | |
| 3.2.1.1.3 | | Display Control – Channel Selection | ✓ | |
| 3.2.1.1.4 | | Low Battery Indicator | ✓ | |
| 3.2.1.1.5 | | Channel Output Zeroing | ✓ | |
| 3.2.1.1.6 | | JES Output Signals | ✓ | |
| 3.2.1.1.7 | | Measurement Capability | ✓ | |
| 3.2.2.1 | | Mass Properties | ✓ | |
| 3.2.2.2.1 | | Stowed Envelope | ✓ | |
| 3.2.2.2.2 | | Deployed Envelope | ✓ | |
| 3.2.3A | 7.2 | Reliability, Quality, and Non-Conformance Reporting | ✓ | |
| 3.2.3B | 7.3.1 | Reliability, Quality, and Non-Conformance Reporting | ✓ | |
| 3.2.3.C1 | 7.3.2.1 | Reliability, Quality, and Non-Conformance Reporting | ✓ | |
| 3.2.3.C2 | 7.3.2.2 | Reliability, Quality, and Non-Conformance Reporting | ✓ | |
| 3.2.3.C3 | 7.3.2.3 | Reliability, Quality, and Non-Conformance Reporting | ✓ | |
| 3.2.3.C4 | 7.3.2.4 | Reliability, Quality, and Non-Conformance Reporting | ✓ | |
| 3.2.3.1 | | Failure Propagation | ✓ | |
| 3.2.3.2 | 7.2.1 | Useful Life | ✓ | |
| 3.2.3.2.1 | | Operational Life (Cycles) | ✓ | |
| 3.2.3.2.2 | | Shelf Life | ✓ | |
| 3.2.3.2.3 | | Limited Life | ✓ | |
| 3.2.5.1.5C2 | 6.3.1.2A | Pressure Rate of Change - Carrier (Orbiter) | ✓ | |
| 3.2.6.1 | 6.3.1.3 | Launch and Landing | ✓ | |
| 3.2.7.3.2A | 6.3.3.2B | HRF Software Requirements - Software Execution Environment | ✓ | |
| 3.2.7.3.2B | 6.3.3.2C | HRF Software Requirements - Repeatable Software Executable Results | ✓ | |
| 3.2.7.3.2C(2) | 6.3.3.2D | HRF Software Requirements - DGCS | ✓ | |
| 3.2.7.3.2D | 6.3.3.2E | HRF Software Requirements - Real-time Data Formatting | N/A | |
| 3.2.7.3.3 | 6.3.3.3 | ISS Command and Data Handling Services Through HRF | ✓ | |

✓ - Requirement is applicable E - Exception N/A - Requirement is not applicable

APPENDIX C

FUNCTIONAL PERFORMANCE VERIFICATION MATRIX

| SRD Section | LS-71000 Section | Requirement | Applicable | **Comments** |
|---|---|---|---|---|
| | | Common Software Interface | | |
| 3.2.7.3.4 | 6.3.3.2A | CSCI Adaptation Requirements | ✓ | |
| 3.3.5.1.1B | | Mating/Demating of Powered Connectors | ✓ | |
| 3.3.6.2.1A | 6.4.3.5.1 | Rack Mounted Equipment - Color | N/A | |
| 3.3.6.2.1B | 6.4.3.5.1 | Rack Mounted Equipment - Finish | N/A | |
| 3.3.6.2.1C | 6.4.3.5.1 | Rack Mounted Equipment - SIR Drawer Panel Handle Latches - Finish | N/A | |
| 3.3.6.2.2A | 6.4.3.5.2A | Stowed/Deployable Equipment - COTS Equipment Non-repackaged - Finish | ✓ | |
| 3.3.6.2.2B | 6.4.3.5.2B | Stowed/Deployable Equipment - COTS Equipment Repackaged - Finish | ✓ | |
| 3.3.6.2.3 | 6.4.3.5.3 | Colors for Soft Goods | N/A | |
| 3.3.6.3B | | Full Size Range Accommodation - COTS Equipment | ✓ | |
| 3.3.8.1A2 | 6.3.1.3A | Structural Design Requirements - Orbiter Loading Middeck Launch and Landing | ✓ | |
| 3.3.8.2.1 | 6.3.2.10 | Batteries | ✓ | |
| 3.5.3.1 | 7.3.3 | Acceptance Data Package (ADP) | ✓ | |
| 3.5.3.1.1 | 7.3.3 | ADP Statement in SOW | ✓ | |

✓ - Requirement is applicable E - Exception N/A - Requirement is not applicable

# APPENDIX D

# ACCEPTANCE AND QUALIFICATION TEST APPLICABILITY MATRICES

# APPENDIX D

## TABLE D-1 ACCEPTANCE AND QUALIFICATION TEST APPLICABILITY MATRIX

| SRD Section | LS-71000 Section | Requirement | Applicable | **SRD Verification Section** |
|---|---|---|---|---|
| 3.4.1 | 5.4.1.1.6.1 and 5.4.1.1.6.2 | Nominal Operation Under Thermal Environment | ✓ | 4.3.1.1, 4.3.1.2 |
| 3.4.2 | 5.4.1.1.3.2-2 and 5.4.1.1.3.2-3 | Workmanship Vibration | ✓ | 4.3.2.1, 4.3.2.2 |
| 3.4.3 | | Functional Performance | ✓ | 4.3.3 |
| 3.4.4 | 5.4.1.1.10 | EEE Parts Control , Selection, and Burn-in | ✓ | 4.3.4 |
| 3.4.5 | 5.4.1.1.8 | Flammability | ✓ | 4.3.5 |
| 3.4.6 | 5.4.1.1.9 | Offgassing | ✓ | 4.3.6 |
| 3.4.7 | 5.4.1.1.5 | Bench Handling | ✓ | 4.3.7 |
| 3.4.8 | 5.4.1.1.1 | Payload Mass | ✓ | 4.3.8 |
| 3.4.9 | 5.4.1.2.1 | EMI/EMC | ✓ | 4.3.9 |
| 3.4.10 | 5.4.1.1.7 | Acoustic Noise | ✓ | 4.3.10 |
| 3.4.11 | | Pre-Delivery Acceptance | ✓ | 4.3.11 |

✓ - Requirement is applicable  E - Exception  N/A - Requirement is not applicable

| TABLE D-2 Non-Critical Hardware Qualification Test Requirements | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Component / Type Test** | **Example Electronic Equipment** | **Example Mechanical Equipment** | **Example Battery** | **Part Number** | **Part Number** | **Part Number** | **Part Number** | **Part Number** |
| Thermal Cycling 7.5 Cycles | ✓ | ✓ | ✓ | | | | | |
| Qualification for Acceptance Vibration | ✓ | ✓ | ✓ | | | | | |
| Flammability | ✓ | ✓ | ✓ | | | | | |
| Offgassing | ✓ | ✓ | ✓ | | | | | |
| Bench Handling | ✓ | ✓ | ✓ | | | | | |
| Payload Mass Control Plan | ✓ | ✓ | ✓ | | | | | |
| EMI/EMC Control Plan | ✓ | | ✓ | | | | | |
| Acoustic Noise Control Plan | ✓ | ✓ | | | | | | |
| EEE Parts Screening | ✓ | ✓ | ✓ | | | | | |
| EEE Parts Control | ✓ | ✓ | ✓ | | | | | |

✓ - Requirement is applicable E - Exception N/A - Requirement is not applicable

| TABLE D-3 Non-Critical Hardware Acceptance Test Requirements | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Component / Type Test** | **Example Electronic Equipment** | **Example Mechanical Equipment** | **Example Battery** | **Part Number** | **Part Number** | **Part Number** | **Part Number** | **Part Number** |
| Thermal Cycling 1½ Cycles | ✓ | ✓ | ✓ | | | | | |
| Acceptance Vibration | ✓ | ✓ | ✓ | | | | | |
| Functional | ✓ | ✓ | ✓ | | | | | |
| Burn-in | ✓ | ✓ | ✓ | | | | | |
| Pre-Delivery Acceptance Functional | ✓ | ✓ | ✓ | | | | | |

✓ - Requirement is applicable E - Exception N/A - Requirement is not applicable

# APPENDIX E

# JHB 8080.5 DESIGN GUIDANCE MATRIX

# APPENDIX E

## JHB 8080.5 DESIGN GUIDANCE MATRIX

✓ = Applicable  N/A - Not Applicable  E = Exception

| | | **JHB 8080.5 DESIGN GUIDANCE SECTION** | | | |
|---|---|---|---|---|---|
| **No.** | **Standard #** | **Abbreviated Requirement** | **App.** | **HRD Section** | **Comments** |
| | **GENERAL** | | | | |
| | G-1 | Equipment Accessibility for Maintenance | ✓ | | Inspect drawing, design, and hardware |
| | G-2 | Separation of Redundant Equipment | ✓ | | Ref. Hardware Item FMEA/Critical Items List (CIL) |
| | G-3 | Systems Checkout Provisions | ✓ | | Inspect drawing, design, and hardware |
| | G-4 | Protection of Spacecraft Electrical and Mechanical Systems from Debris | ✓ | | Inspect drawing and design |
| | G-5 | Interior Design of Spacecraft for Cleanliness | ✓ | | |
| | G-6 | Redundancy Requirements | ✓ | | |
| | G-7 | Time Displays | ✓ | | |
| | G-8 | Redundant Paths - Verification of Operation | ✓ | | |
| | G-9 | Shatterable Material - Exclusion From Habitable Compartment | ✓ | | Inspect H/W Item drawing and design |
| | G-10 | Control of Limited- Life Components | ✓ | | |
| | G-11 | Procurement Document Identification for Manned Space Flight Vehicle Items | ✓ | | Audit procurement documents as necessary |
| | G-12 | Application of Previous Qualification Tests | ✓ | | |
| | G-13 | Shipping and Handling Protection for Space Flight Hardware | ✓ | | |
| | G-14 | Identification and Classification of Flight and Non-flight Equipment | ✓ | | |

## JHB 8080.5 DESIGN GUIDANCE MATRIX (Cont'd)

✓ = Applicable N/A - Not Applicable E = Exception

| | | JHB 8080.5 DESIGN GUIDANCE SECTION | | | |
|---|---|---|---|---|---|
| **No.** | **Standard #** | **Abbreviated Requirement** | **App.** | **HRD Section** | **Comments** |
| | G-15 | Equipment Failure - Verification of Flight Readiness | ✓ | | Discrepancy Report (DR) and Failure Investigation Analysis Report (FIAR) Systems in place |
| | G-16 | Operating Limits on Temperature - Controlled Equipment | ✓ | | |
| | G-17 | Separate Stock for Space Flight Parts and Materials | ✓ | | Reference assembly TPSs and ADP for evidence of traceability |
| | G-18 | Safety Precautions - Test and Operating Procedures | ✓ | | Audit Test Procedures |
| | G-19 | Special Processes - Identification of Drawings | ✓ | | Review Drawings. Applicable to Class I flight equipment only. |
| | G-20 | Spacecraft Equipment - Protection from System Liquids | ✓ | | |
| | G-21 | Spacecraft Equipment - Moisture Protection | ✓ | | Applicable to pressurized compartment |
| | G-22 | Parts Identification | ✓ | | Reference assembly TPSs and ADP for evidence of traceability |
| | G-23 | Pressure Garment Wiring - Ignition of Materials by Electrical Current | ✓ | | |
| | G-24 | GSE and Airborne Support Equipment Protective Devices | ✓ | | |
| | G-25 | Thermal Design and Analysis - Thermal Parameters | ✓ | | |
| | G-26 | Internally Generated Radiation | ✓ | | |
| | G-27 | Fire Control | ✓ | | |
| | G-28 | Sealing - Solid Propellant Rocket Motors | ✓ | | |
| | G-29 | Reentry Propulsion Subsystem In-Flight Test | ✓ | | |

JHB 8080.5 DESIGN GUIDANCE MATRIX (Cont'd)

✓ = Applicable N/A - Not Applicable E = Exception

| | | JHB 8080.5 DESIGN GUIDANCE SECTION | | | |
|---|---|---|---|---|---|
| **No.** | **Standard #** | **Abbreviated Requirement** | **App.** | **HRD Section** | **Comments** |
| | G-30 | Switch Protection Devices | ✓ | | |
| | G-31 | Detachable Crew-Operated Tools - Restriction in Spacecraft | ✓ | | |
| | G-32 | Measurement Systems That Display Flight Information to the Crew - Indication of Failure | ✓ | | |
| | G-33 | Surface Temperatures | ✓ | | |
| | G-34 | Extravehicular Activity Electronic Connectors | ✓ | | |
| | G-35 | Enclosure Panels External to the Habitable Modules | ✓ | | |
| | G-36 | Thermal Blankets - Extravehicular Activity | ✓ | | |
| | G-37 | Verification of Adequate External Visibility | ✓ | | |
| | G-38 | Pressurization or Repressurization - Precluding Ingress of Undesirable Elements | ✓ | | |
| | G-39 | Lightning Protection Design | ✓ | | |
| | G-40 | Radioactive Luminescent Devices | ✓ | | |
| | G-41 | Acoustic Noise Criteria | ✓ | | |
| | G-42 | Solar Wind Environment | ✓ | | |
| | G-43 | Centralized Subsystem Controls | ✓ | | |
| | G-44 | Attitude Control Authority | ✓ | | |
| | G-45 | Solid Propellant Rocket Motors - Ignition Capability with Unsealed Nozzle | ✓ | | |

JHB 8080.5 DESIGN GUIDANCE MATRIX (Cont'd)

✓ = Applicable N/A - Not Applicable E = Exception

| | | JHB 8080.5 DESIGN GUIDANCE SECTION | | | |
|---|---|---|---|---|---|
| **No.** | **Standard #** | **Abbreviated Requirement** | **App.** | **HRD Section** | **Comments** |
| | G-46 | Separation Sensing System - Structural Deformation | ✓ | | |
| | G-47 | Gyroscopes - Verification of Rotational Speed or Drift Rate | ✓ | | |
| | G-48 | Onboard Experiments - Required Pre-installation Checklist | ✓ | | |
| | G-49 | Temperature and Pressure Monitoring Requirements of Hydrogen Peroxide Systems | ✓ | | |
| | G-50 | Direct Procurement of Parts | ✓ | | Audit Procurement Documentation |
| | G-51 | Flight Hardware - Restriction on Use for Training | ✓ | | Controlled through TPSs |
| | G-52 | Reuse of Flight Hardware | ✓ | | |
| | **ELECTRICAL** | | | | |
| | E-1 | Mating Provisions for Electrical Connectors | ✓ | | |
| | E-2 | Protection of Severed Electrical Circuits | ✓ | | |
| | E-3 | Electrical and Electronic Devices - Protection from Reverse Polarity and/or Other Improper Electrical Inputs | ✓ | | |
| | E-4 | Electrical Connectors - Moisture Protection | ✓ | | |
| | E-5 | Electrical Connectors - Pin Assignment | ✓ | | |
| | E-6 | Corona Suppression | ✓ | | |
| | E-7 | Tantalum Wet Slug Capacitors - Restriction on Use | ✓ | | Review Hardware drawings and design |
| | E-8 | Electrical and Electronic Supplies and Loads - Verification Tests | ✓ | | Review TPSs |

JHB 8080.5 DESIGN GUIDANCE MATRIX (Cont'd)

✓ = Applicable N/A - Not Applicable E = Exception

| | | JHB 8080.5 DESIGN GUIDANCE SECTION | | | |
|---|---|---|---|---|---|
| **No.** | **Standard #** | **Abbreviated Requirement** | **App.** | **HRD Section** | **Comments** |
| | E-9 | Electrical Circuits - De-energizing Requirements | ✓ | | Review Drawings, Design, and Test Procedures |
| | E-10 | Cleaning of Electrical and Electronic Equipment | ✓ | | |
| | E-11 | Protective Covers or Caps for Electrical Receptacles and Plugs | ✓ | | |
| | E-12 | Electrical Connectors - Disconnection for Troubleshooting and Bench Testing | ✓ | | |
| | E-13 | Bioinstrumentation Systems - Crew Electrical Shock Protection | ✓ | | Review Drawings and Design, Test protection circuits as part of PDA. |
| | E-14 | Electrical Wire Harness - Dielectric Tests | ✓ | | Ref. Assembly TPS |
| | E-15 | Electrical Power Distribution Circuits - Overload Protection | ✓ | | Review hardware item design and drawings |
| | E-16 | Testing Protective Devices for Solid-State Circuits | ✓ | | |
| | E-17 | Electrical and Electronic Piece Parts - Closure Construction | ✓ | | |
| | E-18 | Circuitry for Automatic Shutdown of Launch Vehicle Engine(s) | ✓ | | |
| | E-19 | Equipment Design - Power Transients | ✓ | | |
| | E-20 | Control of Electrostatic Discharge for Electronic Parts and Assemblies | ✓ | | |
| | E-21 | Electrical Connectors | ✓ | | |
| | E-22 | Ionizing Radiation Effects | ✓ | | |
| | E-23 | Transistors - Selection of Types | ✓ | | |
| | E-24 | Electrical Wire and Cable Acceptance Tests | ✓ | | |

JHB 8080.5 DESIGN GUIDANCE MATRIX (Cont'd)

✓ = Applicable N/A - Not Applicable E = Exception

| | | JHB 8080.5 DESIGN GUIDANCE SECTION | | | |
|---|---|---|---|---|---|
| **No.** | **Standard #** | **Abbreviated Requirement** | **App.** | **HRD Section** | **Comments** |
| | **FLUIDS** | | | | |
| | F-1 | Flow Restriction Requirements - Pressurized Sources | ✓ | | |
| | F-2 | Moisture Separators in a Zero-Gravity Environment | ✓ | | |
| | F-3 | Service Points - Positive Protection From Interchangeability of Fluid Service Lines | ✓ | | |
| | F-4 | Ground Service Points - Fluid Systems | ✓ | | |
| | F-5 | Fluid Lines - Separation Provisions | ✓ | | Applicable only to planned vehicle separation |
| | F-6 | Temperature and Pressure Monitoring Requirements for Potentially Hazardous Reactive Fluids | ✓ | | |
| | F-7 | Capping of Servicing and Test Ports | ✓ | | |
| | F-8 | Fluid System Components Whose Function is Dependent on Direction of Flow - Protection Against Incorrect Installation | ✓ | | |
| | F-9 | Spacecraft Venting - Induced Perturbing Forces | ✓ | | |
| | F-10 | Nozzles and Vents - Protection Prior to Launch | ✓ | | |
| | F-11 | Fluid Supplies - Verification Tests | ✓ | | |
| | F-12 | Protection of Pressurized Systems from Damage Due to Pressurant Depletion - GSE and Airborne Support Equipment | ✓ | | |
| | F-13 | Crew Cabin Module Pressure - Venting Restriction | ✓ | | |

JHB 8080.5 DESIGN GUIDANCE MATRIX (Cont'd)

✓ = Applicable N/A - Not Applicable E = Exception

| | | JHB 8080.5 DESIGN GUIDANCE SECTION | | | |
|---|---|---|---|---|---|
| **No.** | **Standard #** | **Abbreviated Requirement** | **App.** | **HRD Section** | **Comments** |
| | F-14 | Crew Cabin Module Ventilating Fans - Protection from Debris | ✓ | | |
| | F-15 | Separation of Hypergolic Reactants | ✓ | | |
| | F-16 | Fluid Line Installation | ✓ | | |
| | F-17 | Cleanliness of Flowing Fluids and Associated Systems | ✓ | | |
| | F-18 | Pressure Relief Valves - Standardization of Functional Testing | ✓ | | |
| | F-19 | Protection for Tubing, Fittings, and Fluid System Components - Flight Hardware and Associated Equipment | ✓ | | |
| | F-20 | Fluid Systems - Cleanliness | ✓ | | |
| | F-21 | Purge Gases - Temperature and Humidity Requirements | ✓ | | |
| | F-22 | Pressure Garments - Protection Against Failure Propagation | ✓ | | |
| | F-23 | Qualification Fluid | ✓ | | |
| | F-24 | Fluid Systems - Design for Flushing and Draining | ✓ | | |
| | F-25 | Toxicity - Fluids Contained in Systems in the Crew Compartment | ✓ | | |
| | F-26 | Atmospheric Pressure and Composition Control | ✓ | | |
| | F-27 | Liquid or Gas Containers - Verification of Contents | ✓ | | |
| | F-28 | Use of Halogen Method for Coolant System Leak Detection | ✓ | | |

JHB 8080.5 DESIGN GUIDANCE MATRIX (Cont'd)

✓ = Applicable N/A - Not Applicable E = Exception

| | | JHB 8080.5 DESIGN GUIDANCE SECTION | | | |
|---|---|---|---|---|---|
| **No.** | **Standard #** | **Abbreviated Requirement** | **App.** | **HRD Section** | **Comments** |
| | F-29 | Filter Protection of Active Fluid Components | ✓ | | Review Hardware Item design and drawings |
| | F-30 | Pressure Relief for Pressure Vessels | ✓ | | |
| | **MATERIALS AND PROCESSES** | | | | |
| | M/P-1 | Material Selection, Review, and Drawing Sign-off | ✓ | | Review Hardware Item Material Review Cert. |
| | M/P-2 | Flammability of Wiring Material | ✓ | | Review Hardware Item Material Review Cert. |
| | M/P-3 | Toxicity of Materials Used in Crew Compartments - Wire Insulation, Ties, Identification Marks, and Protective Coverings | ✓ | | Review Hardware Item Material Review Cert. |
| | M/P-4 | Metals and Metal Couples - Restriction on Use | ✓ | | Review Hardware Item Material Review Cert. |
| | M/P-5 | Solutions Which Contain Ethylene Glycol - Requirements for Silver Chelating Agent | ✓ | | |
| | M/P-6 | Toxicity - Requirements for Nonmetallic Materials Proposed for Use Within Crew Compartment | ✓ | | Review Hardware Item Material Review Cert. |
| | M/P-7 | Material Detrimental to Electrical Connectors | ✓ | | Review Hardware Item Material Review Cert. |
| | M/P-8 | Leak Detectors - Wetting Agents | ✓ | | |
| | M/P-9 | Breathing Systems - Requirement to Test for Mercury Contamination | ✓ | | |
| | M/P-10 | Liquid Locking Compounds, Restrictions, and Controls | ✓ | | |
| | M/P-11 | Pressure Vessel Documentation | ✓ | | |

JHB 8080.5 DESIGN GUIDANCE MATRIX (Cont'd)

✓ = Applicable N/A - Not Applicable E = Exception

| | | JHB 8080.5 DESIGN GUIDANCE SECTION | | | |
|---|---|---|---|---|---|
| **No.** | **Standard #** | **Abbreviated Requirement** | **App.** | **HRD Section** | **Comments** |
| | M/P-12 | Multi-Layer Blanket Bake-Out | ✓ | | |
| | M/P-13 | Pressure Vessel Design | ✓ | | |
| | M/P-14 | Silicate Ester Coolant System Design | ✓ | | |
| | M/P-15 | Mercury - Restriction on Use | ✓ | | |
| | M/P-16 | Restriction on Coatings for Areas Subject to Abrasion | ✓ | | |
| | M/P-17 | Radiographic Inspection of Brazed and Welded Tubing Joints | ✓ | | |
| | M/P-18 | Etching Fluorocarbon Insulated Electrical Wire | ✓ | | |
| | M/P-19 | Spacecraft Material - Restriction on Use of Polyvinyl Chloride | ✓ | | |
| | M/P-20 | Titanium or its Alloys - Prohibited Use With Oxygen | ✓ | | |
| | M/P-21 | Beryllium - Restricted Use Within Crew Components | ✓ | | |
| | M/P-22 | Brazed Joints - Identification Marks | ✓ | | |
| | M/P-23 | Pressure Vessels - Materials Compatibility and Vessel Qualifications Tests | ✓ | | |
| | M/P-24 | Cadmium - Restriction on Use | ✓ | | |
| | M/P-25 | Pressure Vessels - Nondestructive Evaluation Plan | ✓ | | |
| | M/P-26 | Repair of Sandwich - Type Structures | ✓ | | |
| | **MECHANICAL AND STRUCTURAL** | | | | |
| | M/S-1 | Equipment Containers - Design For Rapid Spacecraft Decompression | ✓ | | Review drawings and design, Test if necessary |

JHB 8080.5 DESIGN GUIDANCE MATRIX (Cont'd)

✓ = Applicable N/A - Not Applicable E = Exception

| | | JHB 8080.5 DESIGN GUIDANCE SECTION | | | |
|---|---|---|---|---|---|
| **No.** | **Standard #** | **Abbreviated Requirement** | **App.** | **HRD Section** | **Comments** |
| | M/S-2 | Alignment of Mechanical Systems | ✓ | | |
| | M/S-3 | Wire Bundles - Protective Coating | ✓ | | |
| | M/S-4 | Hatches - Repeated Use | ✓ | | |
| | M/S-5 | Threaded Fittings - Restrictions on Release of Particles and Foreign Materials | ✓ | | |
| | M/S-6 | Exposed Sharp Surfaces or Protrusions | ✓ | | |
| | M/S-7 | Windows and Glass Structure | ✓ | | |
| | M/S-8 | Penetration of Inhabited Spacecraft Compartments | ✓ | | |
| | M/S-9 | Mechanisms | ✓ | | |
| | M/S-10 | Functional Doors That Operate in Flight | ✓ | | |
| | M/S-11 | Meteoroid Protection Levels for Structures | ✓ | | |
| | M/S-12 | Spacecraft Recovery Hoist Loops | ✓ | | |
| | M/S-13 | Lifting and Hoisting GSE Identification | ✓ | | |
| | M/S-14 | Structural Analysis | ✓ | | |
| | M/S-15 | Stainless Steel Tubing - Method of Joining | ✓ | | |
| | M/S-16 | Pressure Vessels - Negative Pressure Damage | ✓ | | |
| | **PYROTECHNIC** | | ✓ | | |
| | P-1 | Explosive Devices - Arming and Disarming | ✓ | | |
| | P-2 | Pyrotechnic Devices - Preflight Verification Tests at Launch Sites | ✓ | | |
| | P-3 | Wire Splicing | ✓ | | |

JHB 8080.5 DESIGN GUIDANCE MATRIX (Cont'd)

✓ = Applicable N/A - Not Applicable E = Exception

| | | **JHB 8080.5 DESIGN GUIDANCE SECTION** | | | |
|---|---|---|---|---|---|
| **No.** | **Standard #** | **Abbreviated Requirement** | **App.** | **HRD Section** | **Comments** |
| | P-4 | Explosive Devices - Packaging Material | ✓ | | |
| | P-5 | Explosive Devices - Identification Requirements | ✓ | | |
| | P-6 | Protection of Electrical Circuitry for Explosive Devices Employing Hot Bridge Wire Initiators | ✓ | | |
| | P-7 | Explosive Devices - Color Coding Requirements | ✓ | | |

DISTRIBUTION LIST
FOR
LS-XXXXX

NASA
EA5/L. Bauer
SF4/C. Haven
SF2/D. Grounds

LOCKHEED MARTIN
B90/D. Kilbourn
S03/Science Payloads Library
S18/G. Salinas
S22/S. Bhaskaran
S22/J. Thompson
S22/L. Walters
S03/M. Pickett
TBD/D. Barineau
TBD/G. Dalrymple
TBD/P. Nystrom
TBD/J. McDonald